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(Central)
FOR THE YEAR 1953-54
PART II

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Annual Report on the Agricultural Department (Central)

for the year 1953-54

Part II

COCOA SOIL SURVEY SECTION

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INTRODUCTION

The work of the Western Region Soil Survey Section began with a nucleus of 2 Scientific Officers and 12 Junior Staff in March 1951. During the next two years the staff expanded to a strength of 5 Scientific Officers, 1 Agricultural Superintendent, and about 40 Junior Staff. During the past year there has been no further expansion in field staff, except for the posting of 6 newly-trained Agricultural Assistants to the Section from the School of Agriculture in January 1954.

The work to date has consisted of the classification and mapping of the soils on the basis of field characters—chiefly depth, moisture retention (related to the clay content), and penetrability to roots (related to friability). About 40 Soil Series, which are the chief units of mapping employed in modern soil surveying, have been named and variations within these have been described. The suitability of soils for cocoa within the Western Region can to a great extent be determined by systematic field studies of this nature.

Systematic reconnaissance soil surveys are being carried out throughout the cocoa-growing belt of the Western Region, by means of laying out parallel traverse lines 4 miles apart and collecting soil samples for classification at intervals of 220 yards along these lines. Vegetation, land use, and crops are recorded at the sampling points and plotted with the soil records. Nearly all motorable roads are also being mapped. The whole of the cocoa belt in Oyo and Ibadan Provinces has now been covered. A large party began work in Ondo Province in August 1953 and another in Abeokuta Province in February 1954, at which time the total area covered amounted to 5,000 square miles (over one-third of the land in the cocoa belt, if forest reserves are excluded).

From the results of the reconnaissance survey approximate boundaries of "soil associations" can be drawn. What is meant by these can best be explained by giving a list of the Soil Associations which have been mapped up to date:—

- (1) Iwo-Ibadan-Apomu-Asejire Association (Parent rocks :—Coarse gneisses, granites).
- (2) Egbeda-Olorunda-Apomu-Iregun Association (Parent rocks :—Fine-grained gneisses).
- (3) Ondo-Ibadan-Owenna-Apomu Association (Parent rocks :—Mixed gneisses and granites of western Ondo Province).
- (4) Okemessi-Erinoke-Apomu Association (Parent rocks :—Mainly quartz schist).
- (5) Itagunmodi-Araromi Association (Parent rocks :—Amphibolites).
- (6) (Soils of the Igbajo-Imesi Ile granite mass).
- (7) Effon-Apomu-Olorunda Association (Parent rocks :—Mainly sericite schist).
- (8) Araromi-Mokore Association (Parent rocks :—Amphibolites).

In the preceding paragraph the Soil Associations have been given approximately in the order of their extent within the terrain already surveyed. The "Iwo-Ibadan-Apomu-Asejire Association" consists of a mixture of the individual soils which have been named Iwo Series, Ibadan Series, Apomu Series, and Asejire Series, with some others which are less extensive; so also for the other associations.

Most of the good cocoa land (planted or still available) is in the associations numbered (2), (3), (5), and (8) in the above list. Within each association, or in any district which it is necessary to consider as a unit, it is possible to make a quantitative estimate of the actual number of acres or square miles occupied by each soil series, on the basis of the numbers of sampling points on the traverses at which that soil was recorded. Further, the present land use on each soil can also be stated in quantitative terms, by similar means.

Plotting of the data for the whole cocoa belt of Oyo and Ibadan Provinces is not quite complete, but those for the area centred on Ibokun, north-east of Ilesha, where there are good prospects for further cocoa planting, have been summarised. This area has been estimated to be 237 square miles, out of which 24 square miles consist of good cocoa soils already planted with cocoa and 93 square miles of *good* cocoa soils available for new planting. The 93 square miles include 39 square miles of *very good* cocoa soils (Egbeda, Itagunmodi and Araromi Series). The great majority of this available good land is used for food farming at present, on a rotation of 2-3 years' cropping and 6-8 years' bush fallow.

The records indicate that apart from the Ibokun area there is still a considerable amount of suitable soil available for cocoa planting, in the Ife, Akure, and Ondo districts.

After soils have been classified in a reconnaissance survey of a large area, the classification can be used for detailed or semi-detailed surveys of special areas. Much time has been spent on such special work. The Ijebu Plantations Project of the Western Regional Production Development Board (21 square miles) was mapped on the scale 4 inches to 1 mile by means of a semi-detailed soil survey which included production of a contour map with form lines at 20 feet intervals. These maps are being used by the Western Regional Production Development Board as a basis for development of the Project in a modernised fashion, making use of each soil for the crops most suited to it.

Areas amounting to 20 square miles have been mapped in a similar manner to that which was applied to the Ijebu Plantations Project, in the Area of Mass Infection by cocoa swollen shoot virus. Such surveys will, in the long run, be capable of being used for orderly large-scale rehabilitation of some parts of this area. Maps of the present land use were also made. Comparing these latter with the semi-detailed soil maps shows clearly that in the Ibadan District one could seldom find a portion of land larger than 10 acres suitable for cocoa or for citrus (which has less exacting requirements) and not already occupied by cocoa—possibly only poor straggly cocoa, but such that owners would be disinclined to clear it and use the land for another crop.

Numerous scattered and irregular plots or blocks of land have been soil-surveyed for the Western Regional Production Development Board. In the Cordon Sanitaire which surrounds the Area of Swollen Shoot Mass Infection, a soil map has been made of an area measuring 440 x 440 yards around each treated Swollen-Shoot outbreak. Within the Area of Mass Infection, plots where cocoa was cut out a few years ago have been judged as to their suitability for re-planting with citrus, by means of having soil-profile samples taken by Rehabilitation assistants and examination of these in the office.

WORK OF THE PAST YEAR

Reconnaissance Survey of the Cocoa Belt in Ibadan and Oyo Provinces.—The field work of the reconnaissance survey of the southern parts of Ife and Ilesha Divisions was completed in May 1953. Two parties then carried out the reconnaissance surveys of the last two sections of the cocoa belt in Ibadan and Oyo Provinces, one covering the Ede-Oshogbo-Ikirun-Illa area (with a base in Oshogbo) and the other the land north of the Ibadan-Abeokuta and Ibadan-Iwo roads (with a base in Ibadan). The reconnaissance survey of the first area surveyed (in 1951) between the Omi and Oshun Rivers was repeated, applying the more detailed classification of the soils worked out since that time.

Apart from the work of cutting and recording traverses, 590 miles of motor roads (sometimes only dry season roads) were surveyed by compass and chain in these two Provinces at various times.

Reconnaissance Survey in Ondo Province.—A sub-station of the Cocoa Soil Survey was opened at Akure in August 1953, when a Soil Scientist was posted there, with a large party. Main attention has been given to the reconnaissance survey of an area of 1,800 square miles around Ondo and Akure, of which 1,000 square miles have been completed. In the preparation of a base map, 370 miles of roads have been surveyed and plotted.

This area differs from those previously mapped in having large areas of granite (or granodiorite) and considerable amounts of diorite. A few new soil series have been named and studied, but in the majority of cases the soils encountered have fitted into the previous series. In most parts of the area the better cocoa soils have been found to have a patchy distribution, but some sections, each measuring several square miles, have been found, where there is a large proportion of very good soils suitable for new planting of cocoa. These include red and brown clays of Itagunmodi, Owenna, and Araromi Series. There are larger areas of fairly clayey soils of Iwo and Ondo Series, which are thought to be generally satisfactory for cocoa, but not so good; these also provide scope for expansion.

Reconnaissance Survey in Colony and Abeokuta Province.—In February 1954 field work began in the "Otta-Ilaro Area", in the Colony and Abeokuta Province. This area, measuring 1,200 square miles, is bounded by the River Yewa on the west and the River Ogun on the east. The field party, consisting of a Soil Scientist, 3 Agricultural Assistants, 11 other Junior Staff, and about 60 labourers, has been based at Otta.

The soils of this area are formed from sedimentary rocks, and have therefore needed to be classified in entirely different soils series and associations from those which have been recognised in the previous work of the Cocoa Soil Survey. Many deep inspection pits were dug in the early stages of this survey, on this account.

Other Soil Surveys.—Apart from the reconnaissance surveys, the following work was carried out during the year :—

(a) A survey of 9 square miles of land for the proposed Igangan Co-operative Farming Project, in the south of Ilesha Division, and lying immediately to the south of the new Oni River Forest Reserve.

(b) A semi-detailed survey of $2\frac{1}{2}$ square miles of land for a proposed Co-operative Farming project near Alade, south of Akure. (A sample strip of 180 acres within this area was mapped in detail, for the purpose of elucidating problems of classification).

(c) A semi-detailed survey of the Ikonifin Mechanised Farm, near Iwo.

(d) An intensive semi-detailed survey of the Government Farm, Akure.

(e) A rapid survey of the "Oshun Ibude Epo Project" (about 400 acres), near Alagutan, about 6 miles north of the Ijebu Plantations Project.

(f) Detailed surveys of 32 forty-acre blocks, centred on the foci of swollen shoot infection found and cut out in the Cordon Sanitaire (bringing the total number completed to 45, of which two were extended to 360 acres). Recommendations as to the replanting of these areas with cocoa, citrus, or other crops were made.

(g) A rapid survey of the Aro Mental Hospital land near Abeokuta, as a result of which the small portions of this land suitable for cropping were indicated.

(h) An intensive reconnaissance survey of an area of several square miles of land north-east of Iwo, in order to select a section suitable for a citrus plantation to be developed by Western Regional Production Development Board and the Native Authority in partnership. This was followed by a semi-detailed survey of 2,000 acres of this land, and finally an area of about 600 acres of satisfactory land for citrus was selected and recommended to the Board.

(i) Surveys of 56 individual plots suggested for inclusion in Partnership Schemes with Co-operative Societies in the Asejire, Odeyinka, and Agbe-Apitipiti areas in Ibadan and Abeokuta Provinces. These had a total area of 1,070 acres, of which 250 acres were found to be suitable for citrus.

(j) Surveys (of a semi-detailed nature) of the two main irrigation schemes for rice cultivation being developed near Bida, in the Northern Region, by the Department of Agriculture. The soils of the two schemes (each occupying about 4,000 acres) were fully classified into series, such as would be largely applicable in work in swamp-rice areas elsewhere in Nigeria ; it is therefore expected that the results should be of general value. A particular purpose was to select land for the experimental fields of the Central Rice Research Station now being developed near Bida, and recommendations made as a result of the surveys have been adopted. The maps will also serve to guide the siting of trials on out-station plots of the Rice Research Station.

CHEMISTRY SECTION

CHEMISTRY WORK IN THE NORTH

STAFF

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The following summary is taken from the Second Annual Report of the Northern Research Station, Samaru.

FERTILIZER EXPERIMENTS

Standard D.N.P.K. Trials.—The standard series of trials incorporating annual dressings of farm-yard manure with nitrogenous, phosphatic and potassic fertilizers continued at Daura, Kano, Daudawa, Samaru, Bida, Yandev and Maiduguri. Responses due to the higher levels of the four main factors are shown in Table I.

TABLE 1.—D.N.P.K. TRIALS : ALL STATIONS

Station	Crop	Responses in lb/acre to dressings per acre of			
		2 tons F.Y.M.	100 lb super- phosphate	100 lb sulphate of ammonia	50 lb muriate of potash
Daura ..	Guinea-corn plus millet ..	+152*	+67†	+40	+16
Maiduguri	Millet	+241*	+283*	+89	+81
Kano ..	Guinea-corn	+682*	+17	+478†	—36
Daudawa ..	Cotton	+179*	+58†	+91*	+11
Samaru ..	Cotton	+204*	+81†	+80†	+10
Bida ..	Guinea-corn	+466*	+390*	+223*	+15
Yandev ..	Yams	+1,188†	+335	+1,331*	—1,515*

* Difference Significant at $P=.01$

† Difference Significant at $P=.05$

For the first time since the start of these trials a suggestion of detrimental effects from heavy dressings of superphosphate over the smaller dressings has been observed, the stations concerned being Yandev and Kano. Details of the results for these two stations are shown in Table 2.

TABLE 2.—D.N.P.K. TRIALS, YANDEV AND KANO
Responses to Superphosphate

Station	Crop	Unit	Superphosphate dressing		
			Nil	50 lb/ac.	100 lb/ac.
Yandev ..	Yams	lb/ac. tubers	12,105	13,430	12,440
Kano ..	Guinea-corn ..	lb/ac. grain	981	1,027	998
Kano ..	Guinea-corn ..	lb/ac. grain (N absent)	959	845	771

At Yandev, 50 lb/acre of superphosphate gave a yield significantly better ($P=.001$) than nil and ($P=.01$) than 100 lb/acre. 100 lb/acre gave no significantly greater yield than no superphosphate.

At Kano, there was no significant difference in the overall means at any level of superphosphate, but on the plots where nitrogen was absent, there was a marked downward trend with increasing superphosphate.

No detrimental effects have as yet been observed at other stations. The large responses to farm-yard manure in Northern Nigeria appear to be mainly due to its phosphate content. So far no response has been obtained anywhere to potash.

RESIDUAL EFFECTS OF PHOSPHATE

The fertilizer requirements of groundnuts in many parts of the Northern Region have previously been ascertained, and the few scattered trials carried out in 1953 confirmed previous results, namely that on average groundnut soils yielding 700 lb of kernels per acre, an increase of 200 lb of kernels per acre can be expected from an application of 56 lb of superphosphate. The residual effect of superphosphate on groundnuts is being further studied.

At Kano, a trial designed to ascertain the residual effects of farm-yard manure and phosphatic fertilizers on guinea-corn when applied the previous year, showed that only the former produced a significant effect. The responses were as follows:—

Treatment	Yield of threshed guinea-corn grain/acre in lb
Farm-yard manure at 2 tons per acre	+314
Superphosphate at 100 lb/acre	+100
Equivalent P_2O_5 in monammonium phosphate	+47

MINERAL DEFICIENCIES

Sulphur deficiency in groundnuts.—An all stations' trial designed to determine the response of groundnuts to (i) 60 lb superphosphate/acre, (ii) 20 lb of triple superphosphate/acre and (iii) gypsum at a rate equivalent in sulphate content to Treatment (i), indicated that both sulphate and phosphate contribute to the superphosphate effect. A modified trial, designed to give increased precision will be carried out at all stations during 1954.

RESPONSES TO FERTILIZERS

Yams

Ilorin Province.—The experiments designed to ascertain the fertilizer requirements for the principal food crops in Ilorin Province continued during 1953. Three randomised block experiments with yams were laid down at each of three sites, using the same treatments as in 1952, namely six combinations of n_0 , n_1 , n_2 , p_0 , and p_1 where,
 n_0 , n_1 and n_2 =Nil, 60 and 120 lb/acre of sulphate of ammonia
 p_0 and p_1 =Nil and 60 lb/acre of superphosphate.

A summary of the yields from the three centres is presented in Table 3. It should be noted that the data used in the analysis of the results from Ballah was derived from two blocks only in each of the three experiments owing to a variation in planting material.

TABLE 3.—FERTILIZER TRIALS ON YAMS, AT OKEOYI, BALLAH AND PAIYE
(lb Tubers per Acre)

Fertilizer						Oke-oyi	Ballah	Paiye
No Nitrogen	..	..	..	..	..	2,743	10,212	3,792
Increase N ₁ over Nil	..	..	..	..	..	351†	1,083†	1,328†
Increase N ₂ over Nil	..	..	..	..	..	635†	2,278†	1,776†
Increase N ₂ over N ₁	..	..	..	..	..	284†	1,195*	448
No Phosphate	..	..	..	..	..	3,031	11,160	4,987
Increase P ₁ over P ₀	..	..	..	..	..	81	343	—320

* Significant at P=.05

† Significant at P=.01

‡ Significant at P=.001

At each of the three sites, significant responses were obtained to sulphate of ammonia, but not to superphosphate. At both Ballah and Okeoyi, the interaction between nitrogen and phosphate was significant (P=.05).

	Okeoyi		Ballah	
	P ₀	P ₁	P ₀	P ₁
n ₀	2,807	2,678	10,688	9,733
n ₁	3,051	3,137	10,298	12,291
n ₂	3,234	3,521	12,493	12,486
5% Sig. Diff. requires	288 lb		1,647 lb	

At Ballah, nitrogen in the absence of phosphate is only significant at the double rate, but in the presence of phosphate is also significant at the single rate. Likewise phosphate is only significant in the presence of the single rate of application of nitrogen.

At Okeoyi however, nitrogen in the absence of phosphate increases yields, while phosphate in the absence of nitrogen tends to decrease yields. In the presence of each other the trend is to increase yields, and this is significant at the 5 per cent level with the double dressing of nitrogen and the dressing of phosphate.

The Nitrogen X Site Interaction was also significant at Okeoyi, showing that the nitrogen effect although positive at all sites was more marked at some than at others.

The overall result that sulphate of ammonia applications significantly increase the yield of yams in certain areas of Ilorin Province was confirmed in 1953 by a series of Observation Trials carried out by the Agricultural Officer, Ilorin, on farmers' own land, 60 lb/acre sulphate of ammonia giving an average increase of approximately 1,000 lb yams per acre with no further increases due to the addition of superphosphate or extra sulphate of ammonia.

Benue Province.—A trial was laid down at Mbatie on the Tractor Unit Farm, designed to ascertain the levels of nitrogenous, phosphatic and potassic fertilizers required to increase the yield of yams. Two replications of a 3×3 factorial design were used, each replication consisting of 27 plots made up from all combinations of the following three main treatments.

n₀, n₁ and n₂=Nil, 1 cwt and 2 cwt of sulphate of ammonia per acre.

p₀, p₁ and p₂=Nil, 1 cwt and 2 cwt of superphosphate per acre.

k₀, k₁ and k₂=Nil, 46 lb and 92 lb of muriate of potash per acre.

The results obtained, although not significant, indicated a trend towards an increase in both nitrogenous and phosphatic manuring, but not from potassic fertilizers.

A summary of yields, showing main effects only, is presented in Table 4.

TABLE 4.—FERTILIZER TRIAL ON YAMS, AT MBATIE
(Yield of Tubers in lb/acre)

Main Effects								Yield
Sulphate of ammonia								
Nil	..	..	..	..	..	..	..	6,878
1 cwt	..	..	..	..	..	..	..	6,822
2 cwt	..	..	..	..	..	..	..	7,553
Superphosphate								
Nil	..	..	..	..	..	..	..	6,373
1 cwt	..	..	..	..	..	..	..	7,172
2 cwt	..	..	..	..	..	..	..	7,708
Muriate of potash								
Nil	..	..	..	..	..	..	..	7,312
46 lb	..	..	..	..	..	..	..	7,304
92 lb	..	..	..	..	..	..	..	6,637

S.E. = $\pm 418 = 25.0\%$ of G.M.

GUINEA-CORN AND EARLY MAIZE

Ilorin Province.—Guinea-corn and early maize were again included in the series of trials in 1953. Two complete experiments were laid down at each of the three centres previously used, namely Paiye, Ballah and Okeoyi, the first designed to measure the response of early maize interplanted with guinea-corn with fertilizers applied to the maize; the second designed to measure the response of a direct fertilizer application to the guinea-corn.

In both cases, the crop receiving the direct fertilizer application responded significantly, but unfortunately, due to a partial guinea-corn crop failure in the area, it was not possible to substantiate the previous indication that when fertilizer is applied to the maize crop an additional response is also obtained from the interplanted guinea-corn.

A summary of the yields from the three centres is presented in Tables 5 and 6.

FERTILIZER TRIALS ON GUINEA-CORN AND MAIZE, ILORIN PROVINCE,
SHOWING DIFFERENCES BETWEEN TREATMENTS AND NIL
APPLICATIONS IN LB OF THRESHED GRAIN PER ACRE

TABLE 5.—EARLY MAIZE INTERPLANTED WITH GUINEA-CORN

Site			Early Maize			Interplanted Guinea-corn		
			N ₁	N ₂	P ₁	N ₁	N ₂	P ₁
Paiye	..	..	+111*	+107*	+93†	—77	—97	+22
Paiye	..	..	+141†	+184†	+67	Crop Failure. Results not analysed.		
Ballah	..	..	+104*	+217†	—38			
Ballah	..	..	+104†	+176†	+94†	—65	+16	+60
Okeoyi	..	..	+38	+139*	—11	Crop Failure. Results not analysed.		
Okeoyi	..	..	Yields below 200 lb per acre			Crop Failure. Results not analysed.		

* Significant at P = .05

† Significant at P = .01

‡ Significant at P = .001

TABLE 6.—GUINEA-CORN INTERPLANTED THROUGH EARLY MAIZE

Site				Guinea-corn			Early Maize		
				N ₁	N ₂	P ₁	N ₁	N ₂	P ₁
Paiye	..	..		+3	-22	+143†	-41	-31	+29
Paiye	..	..		+94	+66	+190†	+2	+12	-26
Ballah	..	..		+298†	+538†	+84	+72	+92	+39
Ballah	..	..		+94*	+93*	+98†	+9	+88	+10
Okeoyi	..	..		Crop Failure. Results not analysed.			Crop Failure. Results not analysed.		
Okeoyi	..	..		Crop Failure. Results not analysed.			Crop Failure. Results not analysed.		

* Significant at P= .05

† Significant at P= .01

‡ Significant at P= .001

These results confirm the need of guinea-corn at Paiye for phosphate and at Ballah for both types of fertilizer as indicated by the 1952 results.

From the maize yields it would appear that this earlier planted crop also requires both types of fertilizers at all sites.

Trials on Farmers' Own Farms.—In order to ascertain the levels of nitrogenous and phosphatic fertilizers required to increase the yields of various crops under local farming conditions, a series of trials was carried out in Benue and Plateau Provinces during 1953, these were sited on farmers' own farms. Six farms were originally selected in each of eight areas in the two provinces, and on every site, the farmer followed his own particular system of cultivations, the only operations carried out by the Department being the fertilizer applications, and the recording of final yields. Each farm consisted of a single replication of a 3² factorial design, the treatments being three levels each of sulphate of ammonia and superphosphate, alone and in combination, to give a total of 9 plots per farm.

In Plateau Province guinea-corn trials (Tables 8 and 9) were laid down at Andaha and Yelwa, while at Dengi groundnuts and cotton were used as the test crops. Significant results were obtained from all experiments with the exception of the groundnut trial at Dengi where due to poor site selection the number of replications had to be reduced to three. Final yield figures from this trial did, however, indicate a response to the single rate of application of superphosphate (50 lb/acre) but not to the double rate. Sulphate of ammonia applications at both levels resulted in a depression of yield.

In the same area, cotton (Table 7) gave a significant response to both levels of the nitrogenous fertilizer, but did not respond to superphosphate applications.

TABLE 7.—FERTILIZER TRIALS ON COTTON, FARMERS' PLOTS, DENG, PLATEAU PROVINCE (lb/acre Seed Cotton)

				O	N ₁	N ₂	Mean for Phosphate
O	..	..	..	186	226	302	238
P ₁	..	..	..	197	356	326	293
P ₂	..	..	..	169	217	290	225
Mean for Nitrogen				184	226	306	252

Sig. Diff. Main Effects: 1%—88 lb/ac.; 5%—65 lb/ac.

Fertilizer Dressings: 50 and 100 lb/ac. superphosphate and sulphate of ammonia.

TABLE 8.—FERTILIZER TRIALS ON GUINEA-CORN, FARMERS' PLOTS,
ANDAHA, PLATEAU PROVINCE (*lb per acre grain*)

					O	N ₁	N ₂	Means for Phosphate
O	..	..	..	..	492	495	533	507
P ₁	..	..	..	..	668	822	719	736
P ₂	..	..	..	..	606	766	829	734
Means for Nitrogen					589	694	694	659

Sig. Diff.	Main Effects	Interaction
5%	65	111
1%	88	—
0.1%	117	—
<i>Fertilizer Dressings</i> : Sulphate of ammonia 40 and 80 lb/ac.		
Superphosphate 60 and 120 lb/ac.		

TABLE 9.—FERTILIZER TRIALS ON GUINEA-CORN, FARMERS' PLOTS, YELWA,
PLATEAU PROVINCE (*lb per acre grain*)

					O	N ₁	N ₂	Means for Phosphate
O	..	..	..	..	472	511	532	505
P ₁	..	..	..	..	657	802	752	737
P ₂	..	..	..	..	701	690	712	701
Means for Nitrogen					610	668	665	648

Significant Differences. Main Effects : $\left\{ \begin{array}{l} 5\%—80 \text{ lb/acre} \\ 1\%—108 \text{ lb/acre} \\ 0.1\%—143 \text{ lb/acre} \end{array} \right.$

Fertilizer Dressings : 50 and 100 lb/acre superphosphate and sulphate of ammonia.

Results from this first year's series of trials are considered good, and indicate that some very economic responses can be expected from approximately $\frac{1}{2}$ cwt dressings of superphosphate and sulphate of ammonia, guinea-corn yields at Yelwa and Andaha having been increased by 70 and 67 per cent respectively by the N₁P₁ dressing, the outlay involved being £1 per acre for the cost of these fertilizers.

TABLE 10.—FERTILIZER TRIALS ON GUINEACORN, FARMERS' PLOTS, OTURKPO, BENUE PROVINCE (*lb grain per acre*)

	O	N ₁	N ₂	Means for Phosphate
O	440	840	690	657
P ₁	550	745	820	705
P ₂	690	930	920	847
Means for Nitrogen	560	838	810	736

Significant Differences : 5%—166 lb/acre ; 1%—225 lb/acre.

Fertilizer Dressing : 56 and 112 lb/acre superphosphate and sulphate of ammonia.

In Benue Province significant results were also obtained from the trials, although the precision of the experiments was not as high as in Plateau Province. The experiment carried out in Tiv Division was not analysed, average yields being only 157 lb threshed guinea-corn grain/acre with large variations between plots, while at Lafia no significant responses were obtained to either superphosphate or sulphate of ammonia applications.

At Oturkpo and Keffi however significant responses were obtained to the fertilizer applications, and these are summarised in Tables 10 and 11.

TABLE 11.—FERTILIZER TRIALS ON GUINEA-CORN, FARMERS' PLOTS, KEFFI, BENUE PROVINCE (*lb grain per acre*)

	O	N ₁	N ₂	Means for Phosphate
O	620	953	893	822
P ₁	660	1,060	1,313	1,011
P ₂	1,120	1,293	1,227	1,213
Mean for Nitrogen	800	1,102	1,144	1,015

Significant Differences. Main Effects : 5%—231 lb/acre ; 1%—320 lb/acre.

Fertilizer Dressings : 56 and 112 lb/acre superphosphate and sulphate of ammonia.

A series of trials on farmers' own farms was also carried out at Daudawa during 1953 to test the effects of various rates of nitrogenous and phosphatic fertilizers on cotton yields.

The same nine treatments as used in Benue and Plateau were tested,
n₀, n₁ and n₂=0, 50, 100 lb sulphate of ammonia per acre.
p₀, p₁ and p₂=0, 50, 100 lb superphosphate per acre.

Final yield figures showed a significant response to the double dressing of sulphate of ammonia, but not to superphosphate, as shown in Table 12.

TABLE 12.—FERTILIZER TRIALS ON COTTON, SETTLERS' FARMS, DAUDAWA, ZARIA PROVINCE
(lb/acre of Seed Cotton)

Rates of									Sulphate of Ammonia	Superphosphate
Nil	..	..	..	..	..	..	..	..	392	432
50 lb/acre	..	..	..	..	..	..	..	..	446	426
100 lb/acre	..	..	..	..	..	..	..	..	495	476

Differences required for significance at 5% level=64 lb/acre at 1% level=86 lb/acre.
S.E.=19.5% of G.M.

The fact that the 1953 results from Daudawa are in direct disagreement with those obtained in 1949 from experiments carried out on resettlement farms (significant and economic response to superphosphate) is being investigated.

As a whole the 1953 results from all farmers' own farm trials have been good and are being repeated on a larger scale in 1954 in all three provinces reported.

N neem Disorders

In co-operation with the Forestry Department an investigation was carried out during 1953 to ascertain the cause of a condition of yellowing in Neem seedlings (*Melia Azadirachta*) which had been reported from various nurseries in the Northern Region. It was originally envisaged that a series of pot tests, using various nutrient solutions be carried out in order to ascertain if the observed yellowing was due to a lack of a trace element or elements, but during the course of preparation of these trials it was observed that while seedlings under shade were normal and healthy those with no shade were mildly affected with the chlorosis.

This aspect of the problem was investigated first, the effects of temperature and intensity of sunlight on the incidence of yellowing being ascertained by means of different coloured glass cages. The experiment ran for just over a calendar year during which time regular temperature and intensity of sunlight readings were taken, together with periodic observations on growth, vigour and incidence of chlorosis. Results from this trial showed that the observed yellowing was definitely associated with high light intensity, Table 13 illustrating this result.

TABLE 13.—CHLOROSIS IN N neem SEEDLINGS—SUMMARY OF DATA

Treatment			Mean light intensity (candles/sq. ft.)	Mean height of plants (cm.)	Degree of Chlorosis
A. Glass painted black	..	..	Low 15.9	62.9	None
B. Glass painted green	..	..	Low 20.0	68.2	None
C. Glass painted white	..	..	Medium 37.9	54.1	Medium
D. Clear glass	..	..	High 1,600+	44.3	High

SOIL SURVEYS

During 1953 the soil surveys carried out in the Northern Region have been primarily of a reconnaissance nature, and usually conducted in connection with particular schemes at the request of the Director of Agriculture. At Kudaru a survey of the proposed settlement scheme in the Tsetse cleared corridor was carried out and indicated that there was insufficient suitable soil for a large scale settlement scheme. Another reconnaissance survey carried out at Gadau in Bauchi Province also showed insufficient suitable soil present, in this case the

object being to ascertain if the area was suitable for a Groundnut Research Station or sub-station. At Bida a reconnaissance soil survey was carried out to ascertain if the tentative site of the Rice Research Station at Badeggi was representative of the soils in the fadama as a whole. The survey showed that the proposed experimental site was located solely on the light sandy soils of the fadama, and did not include any of the heavier clay soils which appeared to make up the greater percentage of the fadama. As a result a more detailed soil survey was undertaken by the Cocoa Soil Survey from Ibadan.

A detailed soil survey was carried out of the new Lowlands Experimental Farm located near the Shendam Development Area in Plateau Province. An interim report of this work has been prepared and shows that this farm of 2,000 acres is typical of the area, and contains the soils of the area in reasonable proportions. A full comprehensive report of the survey is to be prepared in the coming year.

Another detailed soil survey of a government farm—the Northern Research Station at Samaru has been started, and will be completed and reported in the coming year.

CHEMISTRY WORK IN THE SOUTH

STAFF

Dr H. Vine	..	..	..	..	..	<i>Senior Chemist</i>
V. J. Weston	..	..	..	..	..	<i>Soil Scientist</i>
J. M. Kowal	..	..	..	..	..	<i>Agricultural Development Officer</i>
L. A. Heapy	..	..	..	..	..	<i>Chemist</i>

Dr Vine continued to be on secondment to the Western Region as Officer-in-Charge of the Cocoa Soil Survey, and as in the previous year, he also took charge of the Chemistry section of the Central Research Organisation. The regional activities are reported in full in the Annual Report of the Regional Department of Agriculture and are only summarised here. Work concerned with studies of soil fertility included:

(a) Some fertilizer trials and soil analyses of the savannah area.

(b) A study of the Soil Nitrate changes over a full year both at Moor Plantation and Eruwa, on plots of undisturbed grassland, bare ploughed plots and cropped plots which received manurial treatments.

(c) A study of the Soil Nitrate content during low and high level accumulation in relation to air, soil temperature and soil moisture.

(d) Preliminary incubation tests on the nitrifying ability of Moor Plantation and Eruwa soils together with some routine soil analyses.

In view of this large amount of Regional work it was not possible to embark on any comprehensive Federal programme. The Federal work was mainly concerned with the fertilizer experiments on pineapples and rice, conducted for the Western Regional Production Development Board, and a study of exchangeable bases in oil palm soils.

Fertilizer experiments on pineapples at Moor Plantation and Eruwa.—Four replications of 27 factorial fertilizer experiments at Moor Plantation Field A2, and four similar trials at Eruwa, on pineapples were started in 1952 and progressed satisfactorily. The treatments allocated to the experiments were as follows:—

n_0, n_1, n_2 —nil, 2 and 4 cwt/acre sulphate of ammonia (20% N)

p_0, p_1, p_2 —nil, 2 and 4 cwt/acre superphosphate (18% P_2O_5)

k_0, k_1, k_2 —nil, 1.5 & 3 cwt/acre muriate of potash 60% K_2O)

The fertilizers were applied in September 1952, March 1953, August 1953 and March 1954.

The results are not yet available since the experiments are being still harvested, however, observation on the vegetative growth indicates the following:—

(a) Nitrogen was the limiting factor in both localities. The plants on the plots which received no nitrogenous treatments were yellow in colour and had slightly retarded growth as compared with the plots which received nitrogen.

(b) The outstanding plots especially at Eruwa were those which received double dressings of nitrogen and potash.

Fertilizer Trials on rice : Shaki Area.—At the request of the Project Manager, Western Regional Production Development Board, simple fertilizer trials in the form of 6 pairs of randomised blocks testing N, P, and K were conducted on the swamp rice at Shaki area.

The increases in yield obtained due to the application of 2 cwt per acre of superphosphate although not spectacular (190 lb per acre of paddy or 9 per cent increase) are profitable and worth about £2-10s-0d per acre.

Observations during the late vegetative growth of the rice indicate that the rate of nitrogen application should be low since even 1 cwt per acre of ammonium sulphate in some cases had a lodging effect which was also reflected in depressed yields.

STUDY OF THE CHANGES TAKING PLACE IN THE SOIL AT THE WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH, BENIN, DURING ELEVEN YEARS AFTER CLEARING OF THE FOREST AND ESTABLISHMENT OF OIL PALMS UNDER VARIOUS TREATMENTS

The full laboratory analyses on samples collected in 1941, 1945 and 1951 at the West African Institute for Oil Palm Research from the 5×5 Latin Square experiment, known as the "Establishment Experiment" (F Q1) and from the "Burning *versus* Non-Burning Experiment" (F Q2) were concluded, and the results analysed statistically.

The experiments were designed to study the means of maintaining adequate fertility status in "Acid Sand Type" soils, under Oil Palms, by testing suitable cultural treatments during the early years of plantation establishment.

The results indicate that the problem of maintaining or building up soil fertility in this light, deep and porous sandy soil, containing no food reserves in the form of rotting rock, is closely dependent on the status of the soil organic matter.

The experiment succeeded primarily in illustrating a heavy loss in soil fertility under conditions of continuous intercropping. In contrast bush cover kept cutlassed to knee height—(treatment C), and bush cover about 10 feet high cut once a year—(treatment D), showed only slight variations in the soil organic matter content. Treatment E (leguminous cover) was intermediate in its effect on soil fertility.

The main conclusions at this stage of the experiments are as follows :—

(a) Methods for enhancing or maintaining soil organic matter should be of prime importance in any system of soil management.

(b) The cover density is inversely proportional to oil palm yields, *i.e.*, a lower cover density results in higher oil palm yields.

(c) Although the Acid Sand type of soil can withstand prolonged demands of oil palms and food crops at the same time, without reducing the oil palm yields or producing deficiency symptoms, such treatment exhausts the soil rapidly, and creates soil conditions which would be difficult to correct.

(d) A system of intercropping with food crops in combination with green manuring and application of fertilizers appears to be the most economical and suitable in establishing an oil palm plantation.

Two new experiments on fallows and restoration of soil fertility occupying 25 acres of the old experimental fields at Moor Plantation were started at the beginning of 1953. Work was carried out by field staff under Mr A. O. Bamtefa (Agricultural Superintendent). Details of the experiments were given in last year's Annual Report.

The Federal laboratory staff undertook routine analyses on various soil samples for the Western Region Department of Agriculture, Western Regional Production Development Board, Co-operatives and farmers.

Periodical analyses of lemon juice were continued, about 20 samples of feeding stuff, manures, etc., were also analysed.

BOTANY SECTION

BOTANICAL WORK IN THE NORTH

STAFF

J. H. Gisborne..	..	..	..	..	<i>Principal Agricultural Officer</i>
E. J. Butler	..	..	..	..	<i>Senior Agricultural Officer</i>
A. R. Maurer	..	..	..	..	<i>Botanist</i>
E. Harrison	..	..	..	..	<i>Botanist</i>
A. B. Rains	..	..	..	..	<i>Pasture Research Officer</i>
H. E. King	..	..	..	..	<i>Cotton Breeder (E.C.G.C.)</i>
D. A. Lawes	..	..	..	..	<i>Assistant Cotton Breeder (E.C.G.C.)</i>
W. R. Wilson	..	..	..	..	<i>Laboratory Superintendent</i>
C. W. Morgan..	..	..	..	..	<i>Production Officer</i>
D. J. Iddon	..	..	..	..	<i>Agricultural Superintendent</i>
R. L. Waddell	..	..	..	..	<i>Agricultural Officer</i>

INTRODUCTION

This account of botanical work in the Northern Region of Nigeria is compiled from the Northern Research Station, Samaru, Annual Report 1953-54. The notes include work on agronomy and pasture research.

The rains were very atypical : two showers in late February, traces of rain only twice in March, a completely dry April, and a May rainfall far in excess of any previous record. Towards the end of June there was a dry spell which almost reached drought proportions, and July for the second year in succession proved the wettest month of the year. Early August was fairly dry, but heavy rains later in the month produced the usual waterlogging and drainage problems. The last rain was on the 20th October, and was followed by early onset of harmattan conditions.

METEOROLOGICAL DATA AT SAMARU, 1953

<i>Month</i>				<i>Rainfall 1953 ins. (days)</i>	<i>Average 1924-52 ins.</i>	<i>1953 Mean RH%</i>	<i>1953 Mean Max.°F</i>	<i>1953 Mean Min.°F</i>	<i>1953 Mean Temp.°F</i>
January	..	..	..	—	0.001	27.4	90.6	57.6	74.1
February	..	..	..	0.33 (2)	0.04	35.8	94.8	61.8	78.3
March	..	..	..	—	0.31	44.0	97.3	68.0	82.7
April	..	..	..	—	1.22	26.3	97.4	69.6	83.5
May	..	..	..	10.07 (16)	4.94	63.4	89.4	71.0	84.7
June	..	..	..	5.97 (13)	6.42	70.8	86.9	68.8	77.9
July	..	..	..	11.56 (13)	8.83	74.8	82.6	68.2	75.4
August	..	..	..	8.74 (17)	11.45	76.1	82.0	68.3	75.2
September	..	..	..	8.92 (18)	8.64	70.4	85.3	67.2	76.3
October	..	..	..	0.30 (4)	1.44	52.5	89.8	64.9	77.4
November	..	..	..	—	0.03	22.9	89.4	58.5	73.9
December	..	..	..	—	0.005	21.0	84.7	54.7	69.7
Total	..	..	..	45.89 (83)	43.33	—	—	—	—
Mean	..	..	..	—	—	48.8	89.2	64.9	77.5

COTTON—H. E. KING

The work has continued to consist predominantly of straight reselection and testing of material derived from Samaru 26C and its relatives. A number of introduced types have, however, been kept under observation as possible alternatives to 26C or as potential parents in a hybridization programme. Co-operation in trials of "Egyptian cotton" (*G. barbadense*) in Niger Province and elsewhere has been maintained.

A new departure this season has been a study of cotton seed disinfection for the control of the bacterial disease, *Xanthomonas malvacearum*. For this work Messrs Plant Protection Limited posted Mr R. L. Burgess to work in Northern Nigeria for a season in association with the cotton breeding staff at Samaru and the field staff of the Department at Daudawa.

Co-operation by the cotton breeding staff in agronomic and fertilizer experiments and in the organization of bulk seed multiplication and distribution was maintained.

Both in the yield testing of plant breeding selections and in all other work involving field trials progress has been hampered by difficult local conditions. These result in very wide yield variations, unpredictable fluctuations in pest and disease incidence and in general very high standard errors.

The liberal use of farm yard manure and chemical fertilizers as a means of reducing soil variability clashes with the need to test new strains under conditions not too far removed from those of the cultivators' crop. So also does the use of tractors in soil preparation to overcome labour shortage.

Large numbers of replications and the use of the most modern statistical designs has proved only a partial cure for the soil heterogeneity encountered.

Full details of the results of the season's work have been published in the Empire Cotton Growing Corporation's "Progress Report from Experiment Stations, Season 1953-54".

GROUNDNUTS—(*Arachis hypogea*)—C. W. MORGAN

Breeding work at Samaru.—The new selection programme mentioned in last year's report has gone ahead, but nothing definite can be stated at this stage.

Many of the hybrid nuts set in 1952-53 failed to germinate when planted out; those that did, however, are now pegging.

Despite the lack of facilities it is intended to intensify this line of breeding work. In Daura for example the Local Spreading Variety has always proved superior to anything produced by selection. However, by using the Local Spreading type as one parent on many of our high yielding Samaru varieties it is hoped to release a whole range of new recombinations which can then be selected out.

Classification.—Work is well in hand with a classification of all the varieties of groundnuts maintained at Samaru with a view to being able to place in its respective group any sample of unnamed nuts sent in. The international system, as recommended by the Groundnut Mission, is being adopted. This takes into account not only size, weight and colour of nuts and kernels but also such characters as beak size and shape, type and depth of venation, thickness of testa, etc.

Introductions.—Main interest has centred on a variety Mwitunde being introduced from Tanganyika and said to show some degree of field resistance to rosette disease. Rosette causes considerable losses in crop yield all over the North of Nigeria in some years but especially

in the Middle Belt where complete failure often results from a widespread attack. The variety Mwitunde is said to be mixed and there is hope that superior material may be selected out.

Twenty-one varieties of groundnut were also introduced from Georgia Experimental Station, U.S.A. These were mostly of the Virginia, Runner and Bunch type.

Groundnut Variety Trial A1 (53).—In this trial the seasonal variations of 15 varieties are tested under Samaru conditions. Table 14 shows this year's and previous years' results. Yields this year were higher than average with shelling percentages correspondingly better. MJ.371 which up to last year had held a steady position near the top of the table, fell to thirteenth place. Climatic conditions seemed to favour MK.383 this year; it did well at Samaru and was also in top position of a similar trial at Kano (*see* Table 14).

Mache Atsugune included this year in place of Natal Common seems to have made a good start whereas M'Putu A included in place of Kano 38 was well below any of the others.

Varieties seem to change positions in the table so radically each season that it is difficult to assess their actual value. The average figures over the whole period show that all the long tested varieties are good yielders, and there is little to choose between them, although each year one or two are significantly better than others in that particular year. Varieties which have been better than average more often than not are MK.383, Samaru 38, MJ.371, Castle Cary, MJ.374 and Kano 50.

Groundnut Variety Trial II.—In the experiment in 1953 seven of the "L" selections which had constantly yielded better than Samaru 38 in the reselection trial were included. Five of them gave significantly better yields than Castle Cary and will now go forward to the Main Variety trial next year.

Table 15 gives the adjusted yields per acre in lb in descending order.

TABLE 14.—GROUNDNUT VARIETY TRIALS (I) SAMARU 1946-53

Year	1946	1947	1948	1949	1950	1951	1952	1953	1953 Unshel- led nuts	1953 Shelled nuts	1946-53 Average in lb per acre shelled nuts
No. of Varieties	25	25	12	15	15	15	15	15			
Mache Atsugune ..	—	—	—	—	—	—	—	2	1,852	1,280	[1,280]
MK 383	15	2	7	2	1	2	9	4	1,835	1,248	1,071
Samaru 38	11	5	4	12	5	6	7	3	1,771	1,272	1,054
MK 374	5	3	11	5	8	12	10	1	1,789	1,280	1,046
MJ 371	2	10	6	3	2	5	1	13	1,806	1,163	1,030
Castle Cary	10	6	1	6	4	9	12	9	1,735	1,217	1,028
MJ 374	1	7	2	4	3	13	2	10	1,826	1,215	1,028
Kano 50	—	—	—	—	9	3	5	5	1,739	1,235	1,027
MG 371	4	20	5	10	11	4	11	8	1,743	1,225	1,023
ML 3710	12	19	3	13	13	11	13	7	1,701	1,226	1,015
ML 372	2	15	12	11	15	1	14	6	1,750	1,226	1,014
ML 384	16	4	10	9	10	14	3	11	1,651	1,181	986
ML 378	8	17	7	8	6	8	6	14	1,592	1,149	982
Samaru 38 ex Kon- tagora	—	—	—	—	12	7	8	12	1,768	1,167	944
M'Putu'A	—	—	—	—	—	—	—	15	1,270	858	[858]

Columns 2-9 show the relative positions (out of the total shown below the year) of the varieties in the year named.

Columns 10-12 give yields in lb per acre.

TABLE 15.—YIELDS IN GROUNDNUT VARIETY TRIAL II

<i>Variety</i>	<i>Yield of kernels per acre</i>
L 235	1,463
L 234	1,432
L 245	1,377
L 250	1,367
L 60	1,318
Castle Cary	1,296
L 260	1,292
Mache Atsugune	1,291
Castle Cary <i>ex Bida</i>	1,288
L 258	1,253
Yipa	1,190
Tudun Wada	989
M 'Putu A	731
Kono	426
Toro	379
Sig. diff. at 5 per cent	160

Groundnut Reselection Trial A7 (53).—The best 'L' selections which had gone forward to the second variety trial were replaced by six new reselected varieties, making fourteen in all to be compared with Samaru 38. Castle Cary was also added as a further standard.

Yields were only average, but several of the varieties newly introduced to the trial were superior to Samaru 38. Castle Cary did extremely badly. Table 16 shows the results.

TABLE 16.—YIELDS IN GROUNDNUT RESELECTION TRIAL

<i>Variety</i>	<i>Yield in lb kernels per acre</i>
14T12	827
L 200	815
15A167	805
L 121	751
18B138	742
Samaru 38	739
L 126	696
17B62	677
10A166	655
23T42	644
L 53	627
L 260	589
L 272	579
L 366	561
Castle Cary	410
S.E.	±46

Groundnut Early Varieties Trial A1 (53).—This trial (Table 17) was designed to test the relative yields of 9 of our early maturing varieties and also compare the length of time needed by each from planting to maturity. This is the first year of the trial which will be reported for several seasons. In view of the way varieties seem to fluctuate in performance from year to year, it will be a few years before any positive conclusions can be drawn.

TABLE 17.—GROUNDNUT EARLY VARIETIES TRIAL

Variety						Yield in lb per acre kernels	Days from planting to maturity (approximate)
279-6	..	..	..	..	..	1,134	111
278-4	..	..	..	..	..	970	111
Spanish 205	..	..	..	..	..	953	111
Dixie Runner	..	..	..	..	..	949	123
Natal Common	..	..	..	..	..	880	111
Valencia	..	..	..	..	..	784	111
Kono	..	..	..	..	..	778	111
Phillipine White	..	..	..	..	..	773	123
Toro	..	..	..	..	..	489	111

MILLET—(*Pennisetum typhoideum*)—E. HARRISON

Early Maturing Yield Trial—A5 (53).—55 selections of early maturing millet were compared in a yield trial. The best selection, No. 9, yielded 1,188 lb/acre. The trial is to be repeated in 1954.

Crosses of some of the best of these early maturing selections were made and a trial of 15 hybrids will be laid down in 1954.

It is believed that in some areas, particularly in Plateau Province, gero will not set seed because rain at flowering time prevents fertilization. Millet varieties will be planted in farm garden observation plots in 7 areas in 1954 in an attempt to find suitable gero varieties for these areas.

GUINEA-CORN—(*Sorghum vulgare*)—E. HARRISON

The abnormally low yields of guinea-corn at Samaru in 1953 were apparently due to a combination of heavy stem borer attack and early cessation of the rains.

Dr Webster's programme has been carried on. New crosses between Nigerian and American varieties have been made and selection of the hybrids has continued.

Farafara (Mass Selection) Yield Trial AR15 (52) 53.—This trial was started in 1949 to compare ordinary mass selection of a guinea-corn variety with various modifications of mass selection to determine a satisfactory method of improving a variety on a Provincial Farm. 1953 was the third year in which the eight different methods of mass selection were compared in a yield trial, yields for the three years are shown in Table 18.

There were no significant differences in 1952 or 1953, but as in 1951, normal mass selection gave a somewhat higher yield than no selection.

The conclusion appears to be that, in a well established variety with little inherent variability, normal mass selection of a few good heads selected for size and type, is adequate to maintain the variety. In a less uniform variety, methods 3 to 5 are worth further trial, but there appears to be no need to persist with methods 6 to 8, which were intended to avoid the possibility of contamination in the early stages of selection and multiplication.

American Sorghum Variety Yield Trial—AR17 (52) 53.—This experiment (see Table 19) was a repeat of that carried out in 1952 to compare the yields of 13 American varieties of sorghum.

TABLE 18.—GUINEA-CORN (MASS SELECTION) YIELD TRIAL

<i>Yield in lb grain per acre</i>					1951	1952	1953
1. Control : unselected—a small plot planted and re-established annually from unselected seed					2,135	1,658	284
2. Normal mass selection. The annual selection of 100 good heads selected for size and type					2,495	1,651	377
3. Bulk open pollinated high yielding selections : heads selected as in 2, grown as replicated progeny rows for one year, the eight highest yielders then bulked and subsequently multiplied without further selection					2,365	1,674	313
4. Bulk open pollinated medium selections : ditto, but 8 medium yielders bulked					2,058	1,530	258
5. Bulk open pollinated worst selection : ditto, but 8 worst yielders bulked					1,840	1,616	319
6. Bulk selfed seed from high yielding selections : same selections as method 3, except that original selections were made from selfed heads instead of open pollinated ..					2,055	1,578	341
7. High yielding open pollinated progeny from selfed seed ; as method 3, except that original selections were made from selfed heads instead of open pollinated					2,133	1,649	428
8. Selfed seed from the 8 highest yielding rows planted from selfed plants					2,148	1,537	387
				S.E. ..	±127	±109	±31

TABLE 19.—AMERICAN SORGHUM VARIETY TRIAL

<i>(Yields in lb grain/acre)</i>					1952	1953
<i>Variety</i>						
Hegari					1,733	588
Ladore					1,533	826
Pink Kafir					1,077	282
Martin					930	349
Sedan Red					817	390
Dwarf Shallu 5770					737	145
Redland					705	100
Gurno					679	228
Dwarf Shallu 5651					626	207
Midland					624	228
Redbine					617	149
Dwarf Kafir					475	74
Combine 60					254	122
Short Kaura					(Not included)	15

The local variety Short Kaura, included in 1953 as a control, was useless for the purpose as it was left standing in individual plots in the field after the American varieties had been harvested. American varieties mature about 3 months before the local varieties and we have no comparable local variety to use as a control.

The varieties Hegari and Ladore which gave the highest yields in 1952 were again outstanding. The drawback of these varieties is that they ripen in the middle of the wet season, have to be dried under cover and tend to become mouldy and unpalatable.

CASSAVA—(*Manihot utilissima*)—A. R. MAURER

Cassava Yield Trial (Mosaic Effect) A10 (52).—This experiment is part of a series of trials begun in 1949 to determine the effect of mosaic disease on yield. This year's results were again insignificant and the order of yield did not agree with previous results. The 1949-50 trial was a failure due to lack of planting material. Previous to 1949 a trial had been conducted using "clean" Dan Warri from Samaru *versus* infected Dan Warri from Zonkwa (A2 (48)). The results were significantly in favour of the clean Samaru Dan Warri but no conclusions could be drawn as the Zonkwa strain may not have been identical to that grown at Samaru. The 1949 trial was from plants which became infected during 1948. For results *see* Table 20.

TABLE 20.—CASSAVA MOSAIC YIELD TRIAL

(lb Tubers per acre)

	1948-49	1950-51	1951-52	1952-53
Infected Samaru Dan Warri ..	—	10,966	11,000	10,854
Infected Zonkwa Dan Warri ..	7,020	12,849	12,633	9,114
Clean Samaru Dan Warri ..	10,390	11,873	12,300	8,966
Sig. diff. 1 per cent ..	2,101	N.S.	N.S.	N.S.

The trend reported last year in favour of clean Samaru Dan Warri has not been maintained and there seems to be little difference between yields of infected and clean Dan Warri. This would suggest that infection of Dan Warri variety with mosaic disease has not reduced yields unduly. Further trials are being conducted but 1953-54 results are not yet ready as harvesting takes place in June and July.

Cassava Clones Yield Trial A11 (52).—This trial (Table 21) is a continuation of a series of experiments started in 1950 to test the yields of fifteen varieties. All of these varieties with the exception of CH28, CH50, Dan Warri and Two Cent are open-pollinated seedlings, first grown at Samaru in 1946. Code letters of the female parents of these clones are as follows :

A=Maiduguri Dan Warri E=Ibadan CH28
 B=Ibadan GC 997B H=Minna GC 997B
 C=Ibadan C/36/95

TABLE 21.—CASSAVA CLONES YIELD TRIAL (lb tubers/acre)

Variety or Clone	A8 (50)	A12 (51)	A11 (52)	Average
CH50	13,407	19,219	7,783	13,469
B18	10,959	17,451	7,068	11,826
Dan Warri	8,857	19,421	6,798	11,692
E2	12,944	13,807	8,032	11,594
C15	13,309	13,161	5,888	10,786
B17	12,715	12,678	4,191	9,861
C5	9,843	14,828	4,424	9,692
Two Cent	10,794	13,398	4,390	9,527
H1	6,001	15,193	4,858	8,684
CH28	8,519	11,504	5,715	8,579
C23	3,011	11,386	7,045	7,147
B26	—	7,480	4,306	5,893
B21	8,107	7,323	1,890	5,779
A2	—	5,428	4,478	4,953
B9	5,000	4,593	3,602	4,398
Sig. diff. 5%	4,756	5,901	2,021	—
Sig. diff. 1%	6,422	7,860	2,691	—

Results in 1952-53 were statistically significant and confirm the relative positions of the top yielders of previous trials. It would appear that except for B18 and E2 none of the Samaru clones are equal in yielding capacity to CH50 or Dan Warri. The trial is being repeated.

Cassava Length of Cuttings Observation.—Further observations were made on cuttings of Dan Warri Cassava *ex* Zonkwa. The cuttings were cut to lengths of 6 inches, 9 inches, 12 inches and 15 inches and planted in the normal way. Yields recorded from these cuttings are shown below and are compared with results obtained last year :

				1951-52 <i>lb/a</i>	1952-53 <i>lb/a</i>	<i>Average lb/a</i>
15 Inches	..	..	..	12,928	11,272	12,100
12 Inches	..	..	..	13,635	10,484	12,060
9 Inches	..	..	..	8,888	9,999	9,444
6 Inches	..	..	..	12,827	6,515	9,671

1952-53 results show a direct increase of yield as length of cutting is increased. It would appear that 12 inches cuttings are the most economical size to use although yields may be higher when 15 inches lengths are used. The trial is being repeated.

The question of optimum length of cuttings is of importance because in the Northern Region the above-ground growth of cassava is much lighter than in the South. The rate of multiplication of a variety is therefore very slow, and it is necessary to use the shortest satisfactory length of cutting.

SOYA BEAN—A. R. MAURER

Interest in soya beans has been renewed during the year and efforts are being made to establish varieties in the Kontagora Division of Niger Province. It may be found suitable as a cash crop in parts of the province where groundnut culture is uneconomic due to the prevalence of rosette disease.

Soya beans are well established in Benue Province and are grown after benniseed. In this Province, results to date at Yandev have shown the varieties Malayan and Bilomi No. 1 to be superior in yield to Benares and Dixie.

BENNISEED (*Sesamum indicum*)—A. R. MAURER

As in past years, all selection work and yield trials were carried out at Yandev. The aim of the breeding programme is to develop heavy yielding strains reaching maturity within 89-100 days.

Family and Strains Trial.—This trial consisted of strains reselected in twelve families, previously selected for early maturity from single plants in 1949. Strains from selections were grouped with Yandev unselected material (U) to give 10 families.

To determine the earliness on a numerical basis, the percentage of mature plants was taken at the time when the first few plants of Yandev unselected benniseed (planted at the same date) were beginning to reach maturity.

Analysis of yields of strains within families was performed and significant differences were found in families A, B, F, H and J.

The analysis between families on the basis of yields gave the results shown in Table 22.

TABLE 22.—SUMMARY OF YIELDS : BENNISEED EARLY SELECTIONS TRIAL,
YANDEV (*lb seed per acre*)

Family	1953	1952
A	125	374
B	117	280
U	94	293
E	82	272
D	80	299
H	74	347
F	73	259
C	71	265
J	70	311
G	55	236
5% significant difference	18.4	68.35
1% significant difference	24.5	91.45

Although results were significant, only two families, *i.e.*, A and B yielded better than Yandev unselected (at $P=.01$ and $.05$ respectively). As observed in 1952, the highest yielding family was not necessarily earliest in maturity.

Table 23 shows the percentage maturities obtained for the various families and these were analysed after angular transformation.

TABLE 23.—BENNISEED (EARLY SELECTIONS—% MATURITY)

1952				1953			
Family	% Mature plants	% Trans- formed to degrees	Average No. of days to full maturity	Family	% Mature plants	% Trans- formed to degrees	Average No. of days to full maturity
F	47.5	43.6	99.2	B	36.9	37.4	105
B	42.0	40.4	92.2	H	16.3	23.8	105
C	21.3	27.5	94.6	F	13.1	21.2	105
J	11.9	20.2	96.9	C	6.8	15.1	105
D	11.7	20.0	96.6	A	6.2	14.4	105
H	11.3	19.7	93.3	D	4.3	11.7	105
E	10.7	19.1	97.5	G	3.7	11.1	105
G	10.4	18.8	97.0	E	3.5	10.7	105
A	6.8	15.1	98.0	U	2.0	8.1	112
U	2.6	9.2	104.0	J	1.3	7.5	105
Sig. diff. at 5%	13.5				9.19		
Sig. diff. at 1%	18.1				12.27		

All strains reached maturity in a longer time than last year. This may be attributed to the lateness of the "short dry" spell in August and to heavy rains and overcast skies during the period of growth.

Strains B, H, and F were found to be significantly earlier than Yandev Unselected and strain J ($P=.01$).

Strains B and F have been within the top three strains in earliness for two years now and it would appear that they are definitely retaining this characteristic.

Table 24 compares results obtained in 1952 and 1953.

TABLE 24.—BENNISEED EARLY SELECTIONS, YIELD AND MATURITY DATA

Order	1952				1953			
	Earliness	% Trans- formed to degrees	Yield lb/acre		Earliness	% Trans- formed to degrees	Yield lb/acre	
1st ..	F	43.6	A	374	B	37.4	A	125
2nd ..	B	40.4	H	347	H	23.8	B	117
3rd ..	C	27.5	J	311	F	21.2	U	94
4th ..	J	20.2	D	299	C	15.1	E	82
5th ..	D	20.0	U	293	A	14.4	D	80
6th ..	H	19.7	B	280	D	11.7	H	74
7th ..	E	19.1	E	272	G	11.1	F	73
8th ..	G	18.8	C	265	E	10.7	C	71
9th ..	A	15.1	F	259	U	8.1	J	70
10th ..	U	9.2	G	236	J	7.5	G	55

It would appear, from the above results, that family B is the most promising when both earliness and high yielding capacity are compared.

Normal Maturity Benniseed Yield Trial.—A further trial of the two strains A—(055) and B—(064) selected and tested in 1952 was carried out in 1953 and another strain C—(0361) selected from the 1952 plots was included. These strains have maintained the desirable heavy yielding character since 1949. Yandev unselected 'D' was included as a control.

The layout was as in 1952, *i.e.*, a simple randomised block of 9 replications, and yields are shown in Table 25.

TABLE 25.—BENNISEED YIELD TRIAL YANDEV
(Lb seed per acre)

Strains	1953	1952
064	275	453
055	234	501
(Yandev Unselected)	230	428
0361	230	—

The results obtained were insignificant as in last year, but strains 064 and 055 yielded higher than Yandev Unselected.

PASTURE RESEARCH—A. BLAIR RAINS

The work of this section has continued on a very modest scale but with some interesting results and with some success.

In an attempt to find what equipment is required to thresh and clean grass seed a quantity of grass in head was sent in bales to the National Institute of Agricultural Engineering in the United Kingdom. With the equipment at their disposal they were able to decide on the most

suitable machines for the purpose and did in fact produce extremely good, and certainly drillable samples of the four grasses sent which were *Andropogon gayanus*, *Hyparrhenia rufa*, *Pennisetum pedicellatum* and *P. polystachyon*. It is hoped to follow up this work and to establish seed preparation on a practical basis.

Another most stimulating feature has been the behaviour of introduced material from several different parts of the world. While some varieties, as is inevitable, have proved impossible to establish, others have shown much promise, although this must not be taken to mean that the indigenous species are being neglected. Lucerne (*Medicago sativa* and *M. media*) varieties from America have been established and have produced viable seed. Inoculation was essential and a light dressing of superphosphate produced a marked increase in growth. Other promising legumes include *Alysicarpus glumaceus*, *Stylosanthes gracilis* strains, *S. sundaica*, *Phaseolus lathyroides* and several *Indigofera* species. It is, however, too early at this stage to decide what place, if any, they might fill in agricultural practice. Introduced grasses which have shown considerable promise have included strains of *Chloris gayana*, *Cenchrus ciliaris* and *Brachiaria brizantha*.

Experiments have included a trial of *Pennisetum pedicellatum* strains, a comparison of annual grasses ; and experiments with four grasses to determine optimum spacing. Another to investigate crude protein in four grasses subject to different cutting treatment, with and without sulphate of ammonia, has been started.

Results of the *Pennisetum pedicellatum* (Kyasuwa) strain are given in Tables 26 and 27 which show yields in dry weight and crude protein per acre.

TABLE 26.—KYASUWA STRAINS TRIAL—ONCE AND TWICE CUT
(Lb dry weight per acre)

Strain No.					Cut once : 18 weeks after planting	Cut twice : 11 and 18 weeks after planting
1	..	..	..	..	10,990	4,380
10	..	..	..	..	9,700	4,210
21	..	..	..	..	10,620	4,460

In analysing the results for the dry weight there is no difference between the strains but significant difference between plots cut once and those cut twice. The results for crude protein do not show any significant difference between the once cut and the twice cut ; but the twice cut with the higher percentage protein would be the more valuable fodder.

TABLE 27.—KYASUWA STRAINS TRIAL—ONCE AND TWICE CUT
(Lb crude protein per acre)

Strain No.					Cut once	Cut twice
1	..	..	..	..	233.3	209.8
10	..	..	..	..	277.1	263.6
21	..	..	..	..	240.7	252.9

The experiment involving annual grasses is also incomplete but the results obtained are given in Table 28. The grasses employed were *Pennisetum pedicellatum* Strain 10, *Rottboellia exaltata* and a fodder Sorghum ; *Chloris gayana* was introduced to compare the behaviour of a perennial grass.

Cutting treatments were : one cut, eleven weeks after planting (and the aftermath cut ten weeks later) ; and two cuts, one seven weeks after planting the second ten weeks later ; it must be mentioned that it was not originally planned to cut any aftermath.

TABLE 28.—COMPARISON OF CUTTING TREATMENTS—4 SPECIES OF GRASS
(Equivalent lb dry matter per acre)

Weeks after planting	11	21		7	17	
Species	Cut	After- math	Total	1st Cut	2nd Cut	Total
<i>Pennisetum pedicellatum</i> ..	4,670	3,180	7,850	270	8,080	8,350
<i>Rottboellia exaltata</i>	7,060	1,390	8,450	2,110	3,880	5,990
<i>Sorghum sp.</i>	5,997	1,358	7,355	1,828	3,952	5,780
<i>Chloris gayana</i>	3,156	3,154	6,310	390	4,790	5,180

Although there is a significant difference ($P=.05$) between treatments, the more interesting information is in the figures themselves. The two massive grasses, *Sorghum* and *Rottboellia* produced more bulk in one cutting than in two ; they did not recover quickly after cutting. The *Chloris* and *Pennisetum* were slower starting (small seed) but were more flexible, and the productivity of the *Chloris*, a perennial, was interesting.

Root samples were taken from the plots and these figures are also given (Table 29).

TABLE 29.—COMPARISON OF CUTTING TREATMENTS—ROOT WEIGHTS
(Lb dry matter per acre)

Species						Cut and Aftermath	Two Cuts
<i>Pennisetum pedicellatum</i>	..	..	..	..	..	304	245
<i>Rottboellia exaltata</i>	..	..	..	..	..	126	208
<i>Sorghum sp.</i>	..	..	..	..	..	274	172
<i>Chloris gayana</i>	..	..	..	..	..	244	275

It should be mentioned that the *Chloris* and *Pennisetum* both produce a finer root system than the other grasses.

The spacing experiment includes four grasses *Cenchrus ciliaris*, *Chloris gayana*, *Pennisetum polystachyon* and *Andropogon gayanus*, sown as spaced plants, in rows, and in a sward. Two of the grasses are of the large tussock type (*Pennisetum* and *Andropogon*) and the other two are low growing in habit.

The Experiment was sown at beginning of June 1953 and is now in its second year.

Tabulated Results up to the present time are set out in Tables 30 and 31.

TABLE 30.—SPACING EXPERIMENT WITH FOUR SPECIES OF GRASS
(Lb per acre dry matter)

						<i>Cenchrus ciliaris</i>	<i>Chloris gayana</i>	<i>Pennisetum poly- stachyon</i>	<i>Andropogon gayanus</i>
<i>First cut, August 1953</i>									
Spaced	..	..	..	..	..	451	869	700	1,239
Rows	..	..	..	..	..	1,399	1,799	2,022	2,570
Sward	..	..	..	..	..	1,354	2,085	1,395	1,770
<i>Second cut, Dry Season 1953-54</i>									
Spaced	..	..	..	..	..	1,719	3,253	2,325	2,251
Rows	..	..	..	..	..	1,838	2,498	1,896	2,062
Sward	..	..	..	..	..	484	1,840	753	2,049
<i>Third cut (second harvest year) June 1954</i>									
Spaced	..	..	..	..	..	1,063	1,246	1,321	1,634
Rows	..	..	..	..	..	1,087	1,101	1,242	1,809
Sward	..	..	..	..	..	692	1,379	729	1,977
<i>Total to date (3 cuts)</i>									
Spaced	..	..	..	..	..	3,233	5,368	4,346	5,124
Rows	..	..	..	..	..	4,324	5,398	5,160	6,441
Sward	..	..	..	..	..	2,530	5,304	2,877	5,796
Mean	..	..	..	..	..	3,362	5,357	4,128	5,787

TABLE 31.—SPACING EXPERIMENT, SOLUBLE CARBOHYDRATE AND CRUDE PROTEIN
(Sol. Carbohydrate and C.P. in lb per acre)

						<i>Cenchrus ciliaris</i>		<i>Chloris gayana</i>		<i>Pennisetum polystachyon</i>		<i>Andropogon gayanus</i>	
						<i>S. carb</i>	<i>C.P.</i>	<i>S. carb</i>	<i>C.P.</i>	<i>S. carb</i>	<i>C.P.</i>	<i>S. carb</i>	<i>C.P.</i>
FIRST CUT													
Spaced	..	..	..	..	..	131	57	308	142	255	103	490	147
Rows	..	..	..	..	..	501	109	767	132	846	111	1,078	166
Sward	..	..	..	..	..	562	84	958	91	626	61	832	111
Mean	..	..	..	..	..	396	83	678	122	576	92	733	141

While it is true that the results are generally following an overall pattern there are exceptions and at this half way stage to make observations would probably be a mistake.

An observation trial on plant succession subsequent to mowing, grazing, burning and combinations of these treatments at different times of the year has been started at the Stock Farm, Shika. It is intended to assess the changes in botanical composition, including the amount of regeneration of scrub plants which were initially cleared, both during the course of the trial as well as at its conclusion. The productivity of the pastures under each type of treatment is also being studied. It is hoped to commence similar trials at other centres.

An investigation into the germination of seeds of *Cynodon dactylon* has been undertaken, but with inconclusive results. Seeds were collected monthly and sown at two week intervals. Overall germination was .25 per cent; the best germination was found among seed collected at the end of the wet season and in the first month of the dry season. It is not possible to state if there is a dormancy period. It has been suggested that diurnal variations in temperature before sowing increase germination but this cannot be confirmed. As an arable weed *Cynodon dactylon* probably spreads vegetatively, with occasional new plants from seed and from the point of view of control it appears that vegetative parts only need be considered. As a pasture grass germination is too poor to enable it to be effectively established from seed and it suffers seriously from competition after vegetative propagation.

An attempt is being made to study the development of *Andropogon gayanus* particularly the deposition of lignin in the leaf.

BOTANICAL WORK IN THE SOUTH

STAFF

C. A. Thorold	<i>Principal Research Officer</i>	A. J. Vernon	<i>Botanist</i>
T. A. Russell	<i>Senior Botanist</i>	A. O. Bamtefa	<i>Agricultural Superintendent</i>

INTRODUCTION

There was no change in policy for the work of the Botany Section in the South, centred at Moor Plantation, Ibadan, which as in previous years, aimed at the improvement of food crops for both Eastern and Western Regions, in addition to research on tree crops. Mr T. A. Russell proceeded on leave on 13th October prior to retirement. From then to the end of the year, Mr A. J. Vernon, of the Western Region Department of Agriculture was in charge of the section. The shortage of senior staff inevitably restricted the amount of research which could be undertaken.

The Senior Botanist visited the Southern Cameroons in June, and the Botanist toured in the Eastern Region during July and August.

The early onset of the 1953 rains was followed in many parts of Southern Nigeria by spells of drought in April, the total for this month being below average. Crops in some localities suffered through such irregularities in rainfall during the early part of the season. In general, the little dry season was well marked. The rains stopped early, but heavy rain in September and October brought the 1953 total up to average.

METEOROLOGICAL DATA FOR MOOR PLANTATION, IBADAN

							1953	1953	1953	1953
Month					Rainfall	Average	Mean	Mean	Mean	Mean
					1953	1943-52	RH %	Max. °F	Min. °F	Temp. °F
					ins. (days)	ins.	0900	0900	0900	0900
							GMT	GMT	GMT	GMT
January	..	..	..	..	0.15 (2)	0.44	78.3	92.5	72.2	82.3
February	..	..	..	..	3.67 (5)	0.76	77.6	90.7	71.9	81.3
March	..	..	..	..	2.49(12)	2.36	82.2	91.6	72.3	82.0
April	..	..	..	..	3.47 (6)	5.67	81.7	92.5	72.2	82.4
May	..	..	..	..	8.59(15)	6.41	83.1	88.7	71.6	80.2
June	..	..	..	..	6.85(17)	6.71	88.2	85.2	70.6	77.9
July	..	..	..	..	3.50(19)	6.12	88.6	82.6	70.8	76.7
August	..	..	..	..	1.00 (9)	3.38	89.4	81.1	69.4	75.3
September	..	..	..	..	6.83(18)	7.27	89.0	83.7	71.0	77.4
October	..	..	..	..	6.00(18)	7.01	86.4	86.2	70.7	78.5
November	..	..	..	..	2.36 (4)	1.88	84.8	88.5	70.4	79.5
December	..	..	..	..	0.21 (1)	0.23	74.0	90.3	65.2	77.8
TOTAL	..	..	..	..	45.12(126)	48.24	—	—	—	—
MEAN	..	..	..	..	—	—	83.6	87.6	70.7	79.2

Rainfall at the Eastern Region Research Station is given for comparison :—

RAINFALL AT UMUHIA (UMUDIKE), 1953

Months	Inches	Wet Days	Cumulative Total	Previous Average : 30 years (1924-53)	
				Average	Cumulative Total
January	0.40	4	0.40	0.99	0.99
February	3.10	7	3.50	2.19	3.18
March	9.30	11	12.80	4.65	7.83
April	9.29	10	22.09	8.01	15.84
May	18.18	20	40.27	10.84	26.68
June	10.82	19	51.09	12.67	39.35
July	11.15	22	62.24	11.74	51.09
August	9.18	17	71.42	11.80	62.89
September	11.06	22	82.48	13.96	76.85
October	3.74	19	86.22	11.32	88.17
November	2.86	5	89.08	3.44	91.61
December	—	—	89.08	0.72	92.33
	89.08	156	89.08	92.33	92.33

PERMANENT CROPS—T. A. RUSSELL

Cocoa.—The existing spacing and progeny trials at Odo Ona Nla (I.N.A. Cocoa Farm) were continued. A trial to test 12 clones (8 Nigerian—Trinidad hybrids and 4 selections one of which was T38) was laid out in randomised blocks with 6 replications, 6 trees to a plot. On Moor Plantation, all the existing cocoa plots were maintained. Rootstock trials to test the effect of different rootstocks on the growth and yield of T38 used as a scion were planted at both I.N.A. Farm and Moor Plantation. At I.N.A. Farm the layout consists of two 5x5 Lating Squares with single tree plots, while the layout at Moor Plantation is randomised blocks with 11 replications of single tree plots. Table 32 shows yields obtained from the spacing trial at I.N.A. Cocoa Farm planted in 1942.

TABLE 32.—YIELD OF COCOA IN LB WET BEANS PER ACRE AT DIFFERENT SPACING DISTANCES, AFTER 12 YEARS FROM PLANTING

Spacing :—	5' x 5'	6' x 6'	6' x 7½'	7½' x 7½'	10' x 10'	12' x 12'	15' x 15'
Yields in 1953-54	780	820	500	490	160	120	90
Average Annual Yield to date	740	770	690	550	134	140	92

The 6' x 7½' spacing yielded 20 per cent more than the 6' x 6' in 1951-52, while the 5' x 5' was slightly better in 1952-53. With these exceptions the 6' x 6' spacing has always been best. The 1951-52 result was taken at the time as a suggestion that the shift towards wider spacings yielding more than the closer ones was commencing. It is interesting to note that the last two years have failed to confirm that trend ; and that now, twelve years after planting, the two closest spacings have given total yields to date considerably higher than any wider spacing, with 6' x 6' being only 4 per cent better than 5' x 5'.

The yields of the two varieties used were as follows :—

Variety	Local Amelonado	T38
Yield in 1953-54 in lb wet cocoa/acre	390	450
Average annual yield to date	410	480

Although the varietal effect in the last year has been quite typical of the overall varietal effect to date, *i.e.*, T38 about 16 per cent better than local unselected, this effect has not been consistent but has varied considerably between years. T38 tends to do relatively better in years when yields are high (*e.g.*, 35 per cent better in 1952-53 when average yield was 800 lb/acre) and relatively worse in bad years (*e.g.*, 20 per cent less than local unselected in 1950-51 when average yield was 260 lb/acre).

The hybrid seedlings, progeny of the Nigerian selection T38 crossed with high yielding Trinidadian parents continued to show their superiority as shown in Table 33.

TABLE 33.—YIELD OF NINE TYPES OF COCOA SEEDLINGS IN THE TWELFTH YEAR AFTER PLANTING, EXPRESSED IN LB WET BEANS PER ACRE

Type of seedlings						Yield in 1953-54	Average annual yield to date
G	Nigerian T38 x Trinidad seedling T1	..	..	..	..	3,220	1,621
J	Nigerian T38 x Trinidad seedling T3	..	..	..	..	2,820	1,410
H	Nigerian T38 x Trinidad seedling T2	..	..	..	..	3,050	1,300
D	Nigerian selection T38 selfed (F1)	..	..	..	..	2,070	830
E	Nigerian selection selfed twice (F2)	..	..	..	..	1,520	660
F	Nigerian selection selfed twice (F2)	..	..	..	..	1,800	530
C	Trinidad seedling T3 selfed	..	..	..	..	1,420	680
B	Trinidad seedling T2 selfed	..	..	..	..	1,530	710
A	Trinidad seedling T1 selfed	..	..	..	..	830	380

Cocoa, general.—The clonal collection was maintained and additional material from Kew was added.

A large proportion of the produce from I.N.A. Farm was supplied to Cocoa Division for propagation purposes, and smaller quantities of planting material were sent to Eastern Region and the Southern Cameroons.

Citrus.—The threat of the virus disease known as *tristeza* and the need to find rootstocks resistant to it occasioned the planting of two new rootstock trials at Moor Plantation. One trial, an 8 feet by 8 feet Latin Square single tree plot design, included sweet orange variety Agege I on the following rootstocks—Trinidad sour orange, Moor Plantation Sour Orange, Sampson Tangelo, Lake Tangelo, Sweet Orange Agege I, Cleopatra Tangerine, Sierra Leone rough lemon and a seedling Sweet Orange Agege I as a control; while the other trial had Lisbon lemon on Trinidad Sour Orange, Moor Plantation Sour Orange, California Sour Orange, Lake Tangelo, Sampson Tangelo, Sweet Orange Agege I, Cleopatra Tangerine and Sierra Leone rough lemon in a similar design.

MISCELLANEOUS PERENNIAL CROPS

Kola.—Observations on kola were continued, and in response to a heavy demand for white kola seedlings, over 5,000 nuts were supplied.

Pepper.—Encouraging trade reports were received on samples of Indian Black Pepper *Piper nigrum*, grown at Meanja in the Southern Cameroons and at Moor Plantation, Ibadan, in the Western Region. The variety grown in the Southern Cameroons was unknown. Those from Moor Plantation consisted of Balamcotta, Cheriakodi and Kallivalli and included samples treated with hot water.

The Director of the Colonial Products Laboratory submitted the samples to both laboratory and trade tests and commented as follows “the sample of black pepper grown by the Cameroons Development Corporation at Meanja, whilst it has the relatively high starch and low “piperine” contents which seem to be characteristic of Nigerian pepper examined so far,

would seem to be able to compete on level terms with Malabar black pepper. Of the treated and untreated samples of the three varieties, Balamcotta, Kallivalli and Cheriakodi, the treated Kallivalli appears to be the best, and but for the small percentage of light-coloured berries, would be as good as best quality Tellichery black pepper. The Cheriakodi treated comes next, and appears to be about the value of Malabar or Lampong black peppers. The untreated peppers are definitely inferior in appearance, only the Kallivalli untreated showing any promise”.

ARABLE CROPS—A. J. VERNON

Maize.—Following the good results obtained with Tsolo, Big Joe, White Tuxpan, and the Bounty lines, in the 1952 trials at Ibadan, a series of trials was laid out at sites scattered widely over Southern Nigeria to determine whether there was any great variation in varietal effect between different sites. At each site two (sometimes three) local varieties were obtained by purchasing from local farmers. In most cases these were not distinct varieties but merely two or three selections out of the local ‘landrace’. Owing to seed shortages it was not possible to include all the promising varieties at each site; but at each site eight varieties were used, invariably including Tsolo, Yellow Bounty, Big Joe, and at least two locals. At all the sites except Ibadan and Umuahia the layout was an 8 feet by 8 feet Latin Square with a plot size of about 1/60 acre. At Umuahia a similar layout was used but with rather larger plots, each plot split into two for early and late sowing dates (two weeks interval). At Moor Plantation, Ibadan, two more widely separated (six weeks interval) sowing dates were used, the layout having whole plots for sowing dates, split into eight for varieties. The results are shown in Table 34.

TABLE 34.—YIELDS OF MAIZE IN LB DRY GRAIN PER ACRE, ACCORDING TO VARIETY, LOCALITY AND DATE OF PLANTING

<i>Site</i>	<i>Moor Plantation</i>		<i>University College</i>	<i>Abeokuta</i>	<i>Akure</i>	<i>Ado-Ekiti</i>	<i>Ipokia</i>	<i>Ilorin</i>	<i>Umuahia</i>		<i>Onitsha</i>	<i>Abak</i>	<i>Average corrected</i>
<i>Planting date</i>	19/3	30/4	12/4	20/3	24/3	25/3	27/3	2/4	10/4	23/4	14/4	10/4	
<i>Variety</i>													
Tsolo ..	2,140	230	740	2,200	1,450	1,400	1,270	1,010	1,280	510	610	600	1,120
Yellow Bounty	1,940	430	810	1,900	1,670	1,060	830	1,090	1,670	560	570	900	1,140
Late Bounty	1,680	460	960	—	—	1,090	930	1,120	1,410	770	510	940	1,130
White Bounty	1,530	280	—	1,600	—	940	730	1,040	1,400	580	—	600	920
Big Joe ..	1,430	360	460	1,650	1,590	920	810	870	1,180	730	490	560	920
White Tuxpan	—	—	790	—	1,560	—	—	—	—	—	540	—	1,140
1st Local	1,420	240	560	1,350	840	930	1,160	760	1,220	530	460	380	} 760
2nd Local	1,370	210	540	1,250	760	820	1,010	570	770	430	420	310	
3rd Local	—	—	530	950	—	—	810	150	—	—	350	140	
Sig. Diff.	195	—	200	175	200	145	200	135	165	—	120	110	

The last column of Table 34 gives the actual overall averages of varieties appearing in all trials; for the other varieties a correction has been made to allow for the relation between the general level of yield of the trials they appeared in and that for those in which they were omitted.

As the table shows, four varieties gave average increases in yield over local ones of the order of 50 per cent, however none of the newer varieties proved consistently better than Tsolo. More interesting than the varietal result, however, was the comparison of sowing dates at Moor Plantation and Umuahia. At the former site, the earlier sowing gave, as an average of all varieties, 1,640 lb dry grain per acre, while the sowing seven weeks later gave a yield of only

320 lb. At Umuahia the earlier sowing averaged 1,280 and the one two weeks later 580. Observations on the incidence of maize rust, *Puccinia polysora* in relation to sowing date made in 1952 had suggested that such an effect might occur, but the magnitude of the effect had been unsuspected. Although it is by no means certain that the higher incidence of maize rust on the later sown maize was the only factor responsible for the lower yield, the fact that there was a statistically highly significant interaction at both Ibadan and Umuahia between sowing date and varieties, with the more rust resistant ones (*e.g.*, the Bounties) being less affected by late sowing than the rust susceptible local and Tsolo, suggests that maize rust is at least partially responsible. A study of figures from various maize fields on Moor Plantation, Fashola, and elsewhere confirmed that the effect was not confined to the two experiments but was general all over Southern Nigeria. Recommendations were made, therefore, regarding the need for early planting in 1954. Table 34 shows there are considerable discrepancies in varietal result between one site and another. When these discrepancies were examined in the light of the known interaction between varieties and sowing date, it was apparent that it was this latter factor, rather than that of the sites, which was responsible. In trials planted relatively early (*e.g.*, Abeokuta) yields were good and Tsolo tended to be the best variety, while trials planted relatively late (*e.g.*, Abak) had much lower yields with the Bounties at the top.

Early Season Maize.—The main Ibadan Trial of new varieties was sown very late owing to the seed of some varieties not being available earlier. The results were :—

	<i>lb dry grain per acre</i>					
Sicaragua X White Bounty	..	..	..	..	..	570
Sicaragua	..	..	..	..	..	560
Mexico 16	..	..	..	..	..	430
Mexico 4	..	..	..	..	..	350
Mexico 7	}	..	..	..	..	290
White Bounty						
Mauritius X Creole						
Mauritius	..	..	..	..	..	230
Tsolo	..	..	..	..	..	220
Mexico 13	..	..	..	..	..	210
Standard error of a treatment	..	..	..	..	..	65

A trial to test "Tsolo" from various department farms against newly imported Tsolo showed no significant differences between Tsolo from these different sources. A trial was carried out at Ibadan to test 16 local selections all collected within a 10 mile radius of Ibadan. The yields ranged from 1,240 to 1,840 lb dry grain per acre the distribution being normal about the mean. This variation cannot be explained by the experimental error, the standard error of a variety being only about 50 lb/acre, but is due to the unexpectedly large variation within the local "Landrace." The selections were similar in appearance and were not distinguished by local farmers as different varieties.

Late Season Maize.—The main new-variety trial at Ibadan included for the first time a good range of the new Mexico varieties though unfortunately the variety believed from observations to be the best of all, namely Mexico I, was still not available in sufficient quantity for inclusion.

<i>Variety</i>	<i>Yield in lb dry grain/acre</i>					
Mexico 4	..	..	..	..	..	1,890
Mexico 7	..	..	..	..	..	1,540
Yellow Bounty	..	..	..	..	..	1,530
Mexico 2	..	..	..	..	..	1,460
Local	..	..	..	..	..	1,410
Sicaragua	..	..	..	..	..	1,070
Tsolo	..	..	..	..	..	1,000

There was a low incidence of maize rust with the result that the susceptible Mexico 4 and local both yielded relatively well. The relatively low yields given by Sicaragua and Tsolo were due to poor seed giving only 50 per cent stand. A simple trial at Ado-Ekiti gave the following result :—

Variety	Yield in lb dry grain/acre
Yellow Bounty.. .. .	2,260
Tsolo	1,890
White Tuxpan.. .. .	1,680
Local (average of 2 selections)	1,500

Again the low incidence of maize rust resulted in remarkably high yields for late maize.

Cowpeas.—Owing to severe eelworm damage, yields were generally low in the Moor Plantation trials, the damage being such as to ruin two of the trials. One outstanding fact, however, was that New Era is very susceptible to eelworm, Mauritius somewhat less susceptible, and Machakos partially resistant. This probably explains why, in the past, New Era has usually been the best variety in trials when yields were high, while Machakos has tended to do relatively better in years when yields were low. One trial on the maize/cowpea intercrop with three varieties of cowpeas and three combinations of maize and cowpea spacings gave a result of some value in spite of the eelworm attack.

The Valuation Index given in Table 35, is the estimated sole maize yield that would have the same value as the combined maize and cowpea, reckoning cowpeas to be worth 50 per cent more than the same weight of maize. It is interesting to note that although cowpea and maize yields separately, vary considerably, the valuation index is relatively constant, only two falling outside the range 900-1,200.

The trials at Umuahia and Abak in Eastern Region gave high yields. The Umudike trial was a 3 sowing date/spacing in a 6 by 6 Latin Square, split into 4 sub-plots for variety. Following the 1953 Umudike results the spacings were made closer at earlier sowing dates, "close" spacing being 1'x4', 18"x4', and 2'x4', at August 4, August 18, and September 2, dates respectively, the "wide" spacings at those dates being 2'x4', 3'x4', and 4'x4'.

TABLE 35.—COWPEA YIELDS EXPRESSED AS LB OF DRY GRAIN PER ACRE WHEN GROWN AS AN INTER-CROP WITH MAIZE

Spacing	Cowpeas 2' × 4' Maize 2' × 4'			Cowpeas 3' × 4' Maize 18" × 4'			Cowpeas 2' × 4' Maize 1' × 4'		
Variety of Cowpea	New Era	Mauritius	Mac-hakos	New Era	Mauritius	Mac-hakos	New Era	Mauritius	Mac-hakos
Cowpeas in lb/acre	345	442	208	282	364	225	329	379	243
Maize in lb/acre	415	272	257	486	515	400	500	372	472
Valuation Index of continued crop	1,100	1,200	700	1,100	1,200	900	1,300	1,100	1,000

TABLE 36.—SUMMARY OF COWPEA YIELDS IN LB DRY GRAIN/ACRE IN
RELATION TO VARIETY, SPACING AND SOWING DATE

Sowing date		Variety				Interaction sowing date and spacing	Sowing Date
		Mauritius	New Era	C725	Onitsha Small		
Early	2' x 4' 1' x 4'	1,504 1,394	1,294 1,452	1,257 1,323	1,128 959	1,319 1,305	1,312
Medium ..	3' x 4' 18" x 4'	1,233 1,207	1,167 1,294	1,029 1,045	733 710	1,070 1,083	1,076
Late	4' x 4' 2' x 4'	576 656	796 904	417 446	377 409	552 615	583
Early		1,475	1,398	1,313	1,062		
Medium		1,242	1,253	1,056	755		
Late		627	866	439	400		

Sig. diff.=160

SPACING							
Wide		1,145	1,125	933	787	998	} non significant
Narrow		1,125	1,261	972	718	1,019	

Sig. diff. = 130

Variety Totals		1,124	1,193	953	752		
		Sig. diff. = 90					

The Abak trial had two sowing dates, equivalent to the Umudike early and late ones, and the same 4 varieties. A spacing of 18' x 4' was used for the early date, and 2' x 4' for the late.

SUMMARY OF YIELDS IN LB DRY GRAIN/ACRE

Sowing Date	Variety				Sowing Dates Total	Sig. diff.
	New Era	Mauritius	Onitsha Small	C725		
Early	1,058	979	832	791	925	—
Late	435	247	203	200	281	380
			Sig. diff.=218			
Variety Totals	737	593	501	480	—	—

Sig. diff.=107

The two trials confirmed the superiority of early August sowing. Mauritius and New Era are superior to the other varieties; and though New Era is clearly the better at later sowings, at the optimum sowing date Mauritius tends to do best. This is in agreement with previous results from Umudike. The yield of 1,500 lb/acre for Mauritius spaced at 2' x 4', early date at Umudike exceeds the highest yield previously obtained by Botany Section by about 500 lb.

Cassava.—A trial was planted in May 1953 to compare three Local varieties with six of the best Botanist's hybrids. The local varieties were ones much used by farmers in the neighbourhood of Ibadan and recognised by them as distinct varieties. Material of each local variety was collected from two sources and these selections were treated as distinct "varieties" in the trial, which thus had 12 "varieties" in all.

Harvest was in May 1954 with yields as follows :—

Variety	Yield tons per acre
Oloronto (<i>ex</i> Erinkoja farm)	12½
Oloronto (<i>ex</i> Akanji farm)	11½
GCH7	7½
Ogunjobi (<i>ex</i> Olapade farm)	6½
Ogunjobi (<i>ex</i> Ponpola farm)	6½
NL5	6½
NH14	6
Dodunfolowo (<i>ex</i> Olapade farm)	6
Dodunfolowo (<i>ex</i> Ponpola farm)	6
NH10	5½
NH49	5½
NH15	4
Significant difference at 5 per cent point	1½

The poor performance of the Botanist's hybrids was not unexpected, as these were originally bred and selected for a mosaic-resistance that has since broken down. The yields of the local selections show two points of considerable interest ; the consistency of yield within each variety, and the great difference in yield between Oloronto and the other two varieties. Presumably these latter have some special features that recommend them to local farmers, for it is unlikely that a yield difference as great as that would not have been observed. On the other hand, it is possible that they are longer term varieties and should not be grown as a one year crop.

Other Arable Crops.—In response to a request from the United Kingdom canning trade an initial trial of Chilean Rice Bean (*Phaseolus vulgaris*) was carried out with encouraging results. This bean is used for making 'Baked Beans.' The fibre plant *Abroma augusta* was introduced from India and grown for the first time. The cassava, yam, sweet potato and legume collections were maintained and the routine cotton Ishan A selection continued.

RICE RESEARCH SCHEME R 514

STAFF

J. E. Y. Hardcastle	<i>Rice Breeder</i>
Vacant	<i>Agricultural Officer</i>

INTRODUCTION

The Headquarters of the Rice Breeding Station at Badeggi are situated in a relatively elevated building site area of 146 acres, which is about 8 miles from Bida the principal town in Bida Division of Niger Province, Northern Nigeria, on the Bida-Badeggi road. The experimental fields are located about one mile from the Research Station in the flood plain of the Gbako river, known locally as the Badeggi fadama. These fields occupy 75 acres within the area of the Badeggi Irrigation Scheme. Work at the station commenced in November 1953, when Mr J. E. Y. Hardcastle, was posted to Badeggi to establish the experimental area. The Department of Public Works commenced the construction programme on the building site in October 1953.

Buildings.—The office, laboratory, store and junior service quarters were completed to roof level by the end of March 1954

Soil Survey.—A Soil Survey of the area controlled by the Badeggi Irrigation Scheme was carried out by Mr R. P. Moss, Soil Scientist, under the general direction of Dr H. Vine, Senior Chemist, from November 1953 to February 1954. As a result of this survey it was found that the soils of the Badeggi fadama are a complex assemblage of 13 soil series, varying in their physical properties from pure sand to a heavy silty clay. As a result it was possible to site the experimental area so that a representative collection of the soil series was included.

Development of experiment field.—An area of 25 acres has already been cleared and irrigation works started, whilst five acres were accurately levelled and banded for planting a permanent collection of about 300 rice varieties. The remaining area of 50 acres is now being cleared.

A number of uniformity trials have been laid down, in order to find the optimum size of plot for accurate small-scale field trials under different physical conditions.

The varietal collection has been harvested, yields and botanical and agricultural characters have been recorded and are being entered on to record cards.

Programme of work.—The immediate objective of the rice research scheme is to improve the quality of rice cultivated in Nigeria by the selection and breeding of local and exotic strains. These will be grown for comparison with local varieties over a wider range of conditions. Subsequently, investigations will be made to determine whether significant yield increases can be obtained through improved cultural methods and applications of fertilizers and organic manures. These aspects will be studied in relation to long term maintenance of soil fertility. The efficient use of water under Nigerian conditions of rainfall and soil type will be a long term study.

PLANT PATHOLOGY—C. A. THOROLD

Banana.—The presence of Panama disease *Fusarium oxysporum* var. *cubense* in the Southern Cameroons is causing concern to the banana industry. The disease is prevalent in the Tiko plain and along the West Coast. It also occurs at Ekona, twenty-five miles north of Victoria on the Victoria-Kumba road and at Mbonge. A disease survey is required before control measures can be formulated.

Trachysphaeria fructigena, first collected at Molyko, near Victoria, Southern Cameroons by Mr F. E. V. Smith, 26th January, 1953, is now considered to be a pathogen of major importance in connexion with "Cigar-end" disease of the fruit.

Other noteworthy records of pathogens on banana from the Southern Cameroons include *Armillaria mellea* from Molyko, Victoria, by Dr J. M. Waterston, 24th March, 1949 and *Sclerotium rolfsii* from Beringa, near Victoria, by Dr J. M. Waterston, 27th March, 1948.

Cassava.—*Cercospora henningsii* caused leaf-spotting in the Northern Region.

Several cassava varieties which hitherto have been free from "mosaic" are now beginning to show symptoms. The extent to which the disease affects yields has still to be determined.

A "wilt" of cassava, of unknown origin caused considerable damage to experimental plots at Samaru.

Citrus.—In February 1954, a new disease occurred at Moor Plantation, Ibadan, which caused much defoliation on sweet orange seedlings, used as stocks for budding with selected sweet orange scion material. Specimens were sent to Dr A. P. D. McClean, Chief, Division of Plant Pathology, Union of South Africa Department of Agriculture. He diagnosed the disease as concentric ring blotch, which is very common in some districts of the Transvaal, but has not previously been recorded in West Africa, although it is known to occur in East Africa. The cause of this disease is still unknown and the Plant Pathologist is undertaking investigations in Nigeria. In the meantime, citrus planting material will not be exported.

Cocoa—Black-Pod Disease.—Large-scale field experiments on the control of black-pod disease were continued at Aponmu in Ondo Province. An area of about 40 acres of cacao had been treated in 1952-53 season. In 1953-54, an additional area of about 185 acres was brought into the spraying trial. The main objective in using this increased acreage was to give the assistants experience and further training in large-scale spraying operations, in anticipation of future extension work amongst farmers in the Province. Subsidiary objectives were the gaining of further information on spraying costs. It seemed possible that a reduced

number of spray applications might be effective in the season following the initial spray application. Accordingly, in order to test this possibility, the area (40 acres) which was sprayed at 3-week intervals in 1952-53 was sprayed at 6-week intervals in 1953-54. The area which was sprayed for the first time in 1953-54 (185 acres) received applications of 1 per cent Carbide—Bordeaux mixture at 3-week intervals. The results from this trial are summarized in Table 37.

TABLE 37.—BLACK-POD PERCENTAGES (% B.P.) AND SPRAYING COSTS IN TWO SEASONS AT APONMU

Season 1952-53		%B.P.	Spraying cost per acre (£)	1953-54		%B.P.	Spraying cost per acre (£)
Sprayed 3-weekly	..	6	17.1	Sprayed 6-weekly	..	6	8.7
Not sprayed	}	70	—	Sprayed 3-weekly	..	12	14.0
Not sprayed				Not sprayed	..	42	—

The table shows that the incidence of black-pod was kept at a low-level (6 per cent) in the area which received applications at 6-week intervals, following an initial treatment (3-weekly) in 1952-53. Thereby, the spraying costs were lowered from £17-1s in the first season to £8-7s in the second season.

The spraying cost for 3-weekly applications was £14-0s-0d in 1953-54 as compared with £17-1s-0d in 1952-53. However, this reduction is due to the number of applications being ten instead of twelve, through a shortening of the period of the spraying programme as shown in Table 38.

TABLE 38.—COMPARISON OF SPRAYING PROGRAMMES IN TWO SEASONS

				Date		Number of Applications
				1st application	Final application	
1952-53	..	..	..	9th April	17th December	12
1953-54	..	..	..	11th May	4th December	10

The later starting date and earlier finishing date in 1953-54 has involved fewer applications (ten) as compared with 1952-53 (twelve), and a reduction in spraying costs for 3-weekly applications, from £17-1s-0d to £14-0s-0d per acre. However, there was less effective control of black-pod disease in 1953-54 (12 per cent black-pod) as compared with 1952-53 (6 per cent black-pod). This disparity is particularly noteworthy because the general incidence of the disease in comparable untreated cacao was less in 1953-54 (42 per cent loss) as compared with 1952-53 (70 per cent loss). It seems desirable, from two season's observations in Ondo Province that spraying for the control of black-pod disease should if possible start in April, rather than in May. However, it is not yet possible to give precise recommendations as to the date when spraying should start, because a number of factors are involved, which vary from year to year. It is believed that rainfall and the presence of immature pods early in the season are of importance amongst the factors to be considered in deciding when spraying should start.

Observations have been continued on the dispersal of the causal fungus, *Phytophthora palmivora*. An improved technique has been developed for observations on the take-off of sporangia from an infected pod.

Cotton—H. E. King.—The status of bacterial blight (*Xanthomonas malvacearum*) as a factor affecting yields in Northern Nigeria is not yet well defined. The apparent position over the last seven seasons is summarized below :

1947-48 (*Hutchinson and Pearson*).—Disease present but, having regard to the standard of resistance of Samaru 26C, probably not very important.

1948-49 (*Departmental Staff*).—Recorded, with some strain differences observed but not noted as serious on 26C.

1949-50 (*Cotton Breeder*).—Symptoms (angular leaf spot and vein blight) considered to be sufficiently extensive and severe to reduce yield of 26C. Strain differences marked, many imported types more susceptible.

1950-51 Much less in evidence, late in appearing. Strain differences not easily seen. Attempt to produce infection by spraying with inoculum unsuccessful.

1951-52 Again symptoms late in appearing and never reaching serious proportions. Importance of the disease as affecting 26C very much in doubt.

1952-53 Much more obvious widespread and serious. Some 26C selections of previous two seasons now found to lack adequate resistance.

1953-54 Again marked but possibly rather less so than in 1952-53. Clearly very variable in its incidence from field to field.

Dr G. M. Wickens, Senior Plant Pathologist of the Empire Cotton Growing Corporation, Uganda, who visited Northern Nigeria in November 1953, expressed the opinion that the general level of leaf infection was such as to be capable of reducing yield considerably. In addition on some crops infection on sympodial branches was severe enough to cause appreciable direct loss of fruits.

It was further noted that damage was far more prevalent and severe where growth was poor as a result of poor soil, waterlogging and delayed weeding. Under better conditions the plants seemed able to tolerate a high degree of infection by the pathogen and display strong stem resistance and some degree of leaf resistance.

The great variation in intensity of infection and nature of symptoms makes it virtually impossible to suggest any figure for the loss of yield which may be caused by this disease and also to design and carry out a trial to provide a sound figure for loss under natural conditions.

Evidence was, however, obtained from seed disinfection trials this season that a reduction in visible symptoms can, *in certain circumstances*, be followed by a marked increase in yield.

Mr R. L. Burgess of Messrs Plant Protection Limited laid down and supervised a number of replicated trials at Samaru and Daudawa using as seed dressings a number of chemical compounds known to reduce seed infection. In addition some larger observation areas were planted in co-operation with the Senior Agricultural Officer, Daudawa.

Briefly these trials showed that seed disinfection, particularly with organic mercuric compounds, could result in conspicuously less visible infection on seedlings and young plants and that this relative freedom from symptoms persisted for much of the season. The protection so afforded could be shown statistically to be associated with a quite marked yield increase in one experiment and an apparent relationship appeared also in certain of the observation areas.

In three other experiments obvious symptoms of disease failed to develop on the plants from untreated seed and no advantage whatever could be claimed for seed treatment.

It seems probable that the routine treatment of cotton seed for planting could have an appreciable effect on average but that its value will be dependent on season and local conditions. In any particular instance it may be that no improvement in yield can be demonstrated because conditions are unfavourable to the development of the disease or the untreated seed does not carry viable infection. The possibility of seed disinfection being rendered useless by infection coming in later from elsewhere has not yet been demonstrated in Northern Nigeria but must also be considered. Widespread use of disinfected seed over a number of years would perhaps reduce this danger.

On balance, the chances of seed disinfection proving economic seem good and continued trials are strongly indicated. The cost, with a battery of hand churns dressing a quantity of 37 tons, has been calculated as barely one shilling per acre. This requires an additional yield of seed-cotton per acre of three pounds only to make the process profitable. There would, however, be some difficulty in organizing the mass disinfection of 15,000 tons of seed annually.

It is hoped that disinfection of the seed used in the earlier stages of the multiplication scheme may have an effect persisting into the areas receiving the produce therefrom and eliminate the need for dusting the later stages.

Groundnut—*E. Harrison*.—This has been a very poor year for groundnuts in parts of Niger Province due to damage caused by rosette disease (virus). The Groundnut Farm at Kontagora and the Resettlement Scheme in the same district were severely affected and in some cases the yields were reduced to nil. The only groundnuts which yielded reasonable quantities of nuts were those planted early.

A variety of groundnuts, said to be resistant to rosette, has been introduced from East Africa. This variety, Mwitunde, will be grown at Samaru and in Niger Province to observe its performance when planted both early and late, in comparison with that of some of our local varieties and selections.

Other Groundnut diseases reported during the year were the usual leaf spot (*Cercospora arachidicola*) and root rot (*Sclerotium rolfsii*). These two plant diseases are present every year throughout the Region but while the former seldom causes much damage, the latter may reduce yields considerably in localized areas.

Blind nuts have been reported on groundnuts in various parts of the North but it is not known at the moment whether these are caused by nutritional, physiological or pathological factors. The two former are considered more likely.

Guinea-corn (Sorghum)—*E. Harrison*.—Damage caused by covered smut, *Sphacelotheca sorghi* was extensive in some fields of short Kaura at Samaru. Propaganda on control measures against the disease which occurs throughout the Northern Region was given out at Agricultural Shows when the copper carbonate seed treatment was demonstrated. Samples of this compound were sold at Shows and all Agricultural Stations have been issued with supplies.

Gleocercospora sorghi occurred commonly in July on young plants in the Northern Region.

Maize Rust.—Maize rust disease caused by *Puccinia polysora* Underw., was less severe than in the previous year and crop yields were generally good. The lower incidence of the disease in the later part of the season allowed some excellent crops of late maize to be grown.

Millet ("Gero")—*E. Harrison*.—*Sphacelia sp.* was very common on heads of *Pennisetum typhoideum*, in July and August. In some of the late maturing plots the incidence of disease was so heavy that very little normal grain developed. The disease is well known to local farmers as "domana" and the poisonous qualities of the purplish sclerotia are recognised. *Cerebella andropogonis* was common on the surface of infected grains.

Potato (Solanum tuberosum).—Serious losses of potatoes, due to blight, caused by *Phytophthora infestans*, have been experienced in Bamenda Province of the Southern Cameroons. Blight resistant potato varieties have been introduced from Scotland, United States and Canada, which have already given promising results. Mr T. A. Russell has already reported on these trials.

Sugar Cane—*E. Harrison*.—The spread of red rot disease of sugar cane (*Colletotrichum falcatum*) in the Northern Region continues and it has now been confirmed that it is present in all cane growing areas except Sokoto West and Benue Province.

The damage caused by the disease was less than in previous years but reports indicate that it is still of major importance having reduced the tonnage of sugar considerably in certain districts, both directly and by discouraging planting.

Cultures of different strains of the fungus are being prepared at Samaru for inoculation into all existing and newly introduced varieties of sugar cane.

A suitable technique for producing inoculum for this purpose consists of floating cellophane discs on the surface of an oatmeal broth with the addition of one per cent sucrose. Cultures are kept in the dark until the mycelium has grown over the disc. They are then transferred to daylight when spores are freely produced after five days.

Newly introduced varieties of cane said to be resistant to Red Rot are being multiplied at Samaru and Maigana.

Tomato—*E. Harrison*.—Leaf spot caused by *Septoria lycopersici* was locally severe in the Northern Region. Heavy infections in May killed plants when six inches in height.

Yam (Dioscorea sp.).—A disease occurred on yams in a fertilizer trial at the Upper Ogun Estate of the Western Region Production Development Board with the following symptoms. Badly affected plants remained stunted and produced many spindly shoots, and the leaves were narrow and distorted. In less seriously affected plants, the leaves were mottled with a light-coloured streak following the veins. What appeared to be a similar disease, was reported from near Ilorin. It seemed that the disease had been known there for some time, because the local farmers were accustomed to destroying the stunted stands and introducing 'seed' from healthy yams for new plantings. It has not yet been possible to transmit the disease to healthy plants and the cause of the disease is, therefore, still obscure. It is intended that this yam disease will be fully investigated when a plant pathologist is available for such studies.

MAIZE RUST RESEARCH UNIT

STAFF

Dr W. R. Stanton	..	..	..	..	..	Senior Scientific Officer
R. H. Cammack	..	..	..	..	..	Scientific Officer

Research on maize rust, *Puccinia polysora* Underw. continued on the lines mentioned in the previous annual report for the year 1952-53. An Annual Report of the Maize Rust Research Unit is being published separately and the following are brief notes of observations to date.

EPIDEMIOLOGY AND BIOLOGY OF THE PATHOGEN

Reports of the disease have now been received from Kenya, Nyasaland, Rhodesia, Lourenco Marques, Uganda and the islands of Mauritius and Reunion. Investigations on the disease are being conducted in these territories and a close liaison is being maintained with the workers.

Assay plots in Nigeria, Dahomey and the Gold Coast have shown that the disease is confined to the wetter and more low-lying parts of the coast, and that the pathogen, *Puccinia polysora* Underw., is replaced by *Puccinia sorghi* Schw., above elevations of approximately 4,000 feet. No further stages in the life history of the pathogen have been found and all teleutospores examined so far have proved non-viable.

The onset of infection has been found to be earlier in the life of the plant as the rainy season progresses. The rate of spread is found to fall off steadily throughout the rainy season.

During the dry season (November to April), onset of infection is delayed until seven weeks after germination and the rate of spread remains constant. The lowest crop yields are to be found in plots planted late in the growing season. A 50 per cent reduction in yield may then be expected.

The uredospores of *Puccinia polysora* have an optimum temperature for germination of 27°C compared with that of 17°C for *Puccinia sorghi*. At this optimum temperature and 50 per cent relative humidity, the spore may remain viable for 48 days. It is concluded that a perennial supply of the host is essential to the maintenance of the rust fungus.

Further studies of the epidemiology will include the analysis of aerial spore content by continuous air sampling from an open site.

BREEDING AND GENETICS

Resistance to the disease has been found to occur widely among varieties from Central America and Mexico. Two of these have been shown to out-yield local varieties under a wide range of conditions and are being multiplied by the Regional Departments of Agriculture. Resistance appears to be controlled by a simple dominant gene. This mechanism is being used as a working hypothesis in the breeding of new varieties pending more detailed genetical studies.

Work during 1953 was concentrated on the study of yielding ability and other characters of imported maize with a view to their direct use, or after breeding to supplement the two varieties under multiplication. A group of 180 lines of maize imported from Trinidad has shown the possibility of improving yield by the incorporation of a number of disease resistance and agronomic characters. The material is also providing further sources of rust resistance.

As a long term policy, suitable inbreds are being developed from crosses of local and rust resistant lines for the ultimate production of hybrid corn.

ENTOMOLOGY SECTION

STAFF

J. R. G. Sutherland	<i>Senior Entomologist</i>	J. L. Gregory	<i>Entomologist</i>
J. T. Davey	<i>Entomologist</i>	M. A. Choyce	<i>Cotton Entomologist (E.C.G.C.)</i>

The major problems investigated by the Entomology Section included locusts, a study of the control of beetles attacking yams in the Eastern Region, investigations on the control of major cacao pests in the Western Region, and of stem-borers and other pests of cereals.

Mr J. T. Davey continued his secondment to C.I.P.P.A.S. as leader of the mission in the French Sudan which is studying the African Migratory Locust, *Locusta Migratoria Migratorioides*.

STUDIES ON THE CONTROL OF THE CAPSID PESTS OF COCOA—J. R. G. SUTHERLAND

Trials on the control of capsid bugs attacking mature, bearing cocoa were continued throughout the year. There were three main types of experiment, a series of two acre paired plots, a large scale dusting trial and a spraying trial.

An aerosol generator using D.D.T. was also compared with D.D.T. dust but the aerosol had little effect upon capsid populations and the trial was abandoned.

In all experiments, observations were made at ten-day intervals upon the number of capsids present and the number of unripe pods over three inches long in a sample of 100 trees in each plot. The degree of blast on each of the sample trees was also scored three times per month.

Small Scale D.D.T. Dusting Trial.—There were four of these situated in the main cocoa area of the Western Region of Nigeria. Three of the plots were two acres in size, one-half of which was treated with 5 per cent D.D.T. dust, the other half being untreated. The experiment at Odo Ona Nla (I.N.A. Farm) was three acres, two plots being dusted and one untreated. Dusting on all the paired plots began in 1951.

The insecticide was applied at the rate of 20 lb of 5 per cent D.D.T. per acre by means of a knapsack type motor driven dusting machine. The trees were first dusted early in July when capsid populations normally begin to increase and subsequently as capsid counts indicated they were necessary. In previous years, 40 lb D.D.T. per acre had been applied at each dusting.

In the treated plot of three of the four paired plot experiments, capsid populations were kept consistently below the level at which appreciable damage occurs. 5 per cent D.D.T. dust at 20 lb per acre per application was applied twice to these three plots. In the fourth plot dust was applied on seven occasions since the capsid population was very high (it rose to 550 bugs per hundred trees in the untreated as opposed to a maximum of 180 in the treated plots).

The paired plots appear to be of two types. In the first type, represented by Ilesha, Ondo and Ado-Ekiti the initial population in 1951 was more than 300 bugs per 100 trees. In these plots five dustings at 40 lb 5 per cent D.D.T. dust per acre in the first year brought down the populations considerably so that in the second year the maximum was only about half that of the previous year. A further four applications at the same rate reduced capsid numbers so that two dustings at 20 lb per acre in the third year was sufficient to prevent appreciable damage.

It may be that this reduction of the population will be a common phenomenon and that, after heavy applications in the first year or two, lower rates may effectively be applied.

It is interesting to note that in these three plots, the number of capsids in the untreated plot has also been reduced to a level considerably lower than that present in the first year of treatment. Two explanations suggest themselves. (a) The rate of movement of capsids from one plot to another may be very slow or (b) when capsids are controlled the trees regenerate and then produce chupons at a rate lower than that when capsid damage was severe. Capsids are known to favour chupons to fan branches for breeding purposes and it is possible that the number of capsids may be reduced by the scarcity of suitable breeding sites.

The second type of plot is that represented by the Ibadan Native Authority Cocoa Farm. In this, the initial population was much higher than in the plots previously considered, and although the capsid populations were reduced by about 50 per cent at each dusting, the population in the treated plots still remained high.

Little reduction was noted from the first to the third year in capsid populations in either the control or the treated plots at the I.N.A. farm.

The vegetative appearance of trees in the treated plots continued to be better than that of the undusted trees.

The effect of dusting upon yield is not clear. Several factors must influence the yield of cocoa, e.g. (1) climatic conditions (2) the biennial nature of bearing of the cacao tree (3) black-pod disease. As these will influence yield on both treated and untreated plots it is considered better to deal with the ratio between the yields of two plots, rather than with the yields themselves.

In all four paired plots an increase in the yield ratio is indicated following dusting even if this increase in yield is not definitely proven. Results indicate that yield increases of 30 per cent may be produced from the control of capsid in the third year (*see* Table 39). Figures of ripe pods harvested bear out this result on the three plots from which they were taken.

TABLE 39.—SUM OF UNRIPE POD COUNTS ON PAIRED PLOTS (*in Pods per 100 Trees*)

<i>Locality</i>	<i>Plot</i>	<i>July-Dec.</i> <i>1951</i>	<i>July-Dec.</i> <i>1952</i>	<i>July-Dec.</i> <i>1953</i>	<i>1952</i>	<i>1953</i>
Ilesha ..	Treated ..	20,351	15,667	15,934	58,843	37,366
	Control ..	20,303	13,911	16,363	10,411	26,808
	Ratio	1.00	1.13	0.97	1.46	1.39
Ondo 7 ..	Treated ..	4,673	9,106	7,386	21,737	13,459
	Control ..	7,063	7,578	4,782	22,315	8,854
	Ration ..	0.66	1.20	1.54	0.97	1.52
Ado-Ekiti ..	Treated ..	17,557	9,186	10,923	22,441	17,725
	Control ..	13,032	9,672	5,768	18,995	8,025
	Ratio	1.35	0.95	1.89	1.18	2.21
I.N.A. Cocoa Farm	Treated since 1951.. ..	5,378	6,581	5,981	9,995	7,826
	Treated since 1952.. ..	22,417	25,866	22,508	36,263	30,607
	Control ..	—	5,987	4,181	—	8,150

Large Scale D.D.T. Dusting Trial.—The object of this experiment is to determine the effect of application of 5 per cent D.D.T. dust to large areas of cacao upon capsid populations and upon pollination of cocoa flowers. It was also hoped to obtain a realistic estimate of the cost of applying dust.

On 1st July, 70 acres of mature cacao at Akola in Ilesha Division were placed under routine observation. A circular plot of 40 acres in the centre was dusted shortly afterwards and two adjoining plots together comprising 30 acres remained untreated.

Dust was applied at 20 lb per acre on 17th to 25th July, 25th to 28th September and 5th to 9th January.

The first dusting in July was done when the capsid population was very low. The number of capsids in treated and untreated plots began to rise in October after the second dusting. In the untreated plots, the capsids continued to increase in numbers and reached a maximum of 280 bugs per 100 trees in mid January after which they fell off rapidly until the middle of March. In the treated plot, the rise began about two weeks later and did not reach more than 90 bugs per 100 trees after which it fell away rapidly following the third dusting in January.

The population in the untreated plot was above that at which appreciable damage occurs, from the beginning of November until the end of March, whereas that in the treated zone was above this level for two months only.

The scores for capsid blast upon treated and untreated plots were very similar from the beginning of the experiment until the middle of November. After this the amount of damage in the untreated plot became considerably higher than in the treated plot and remained so until the end of March 1954. Thus dusting with D.D.T. markedly reduced capsid damage; the reduction did not appear until after a time lag of four months from the first dusting.

During the early part of the experiment, the number of cherelles set per 100 trees was greater in the untreated than in the treated area. In the last six counting periods, the number of cherelles per 100 trees was greater upon the treated than upon the untreated plots.

Counts of the numbers of cherelles present were taken throughout the period; examination of these figures has shown that it is not possible by this method to gain an accurate picture of the effect of dusting upon pollination of cacao flowers. This is due to the large number of pods which fall within the first fortnight after pollination. Recent observations at Ibadan have indicated that some 20 per cent of cherelles which set may fall in the first five days after setting and a further 10 per cent in the following five-day period.

Counts of green pods during the whole of this period showed similar results to those given by cherelle counts but, as would be expected, the superiority of the treated zone lagged for three counting periods behind that recorded in the cherelle counts.

Cost of Dusting.—The cost of dusting is about 18s per acre of which 12s per acre is the cost of the insecticide and the remainder labour, transport and deterioration of machinery.

Incorporation of D.D.T. into black-pod spray.—In June 1953, an experiment was started at the Government Cocoa Farm at Owena to find out whether capsids could be controlled by adding D.D.T. to the carbide-Bordeaux spray used against black-pod disease, caused by *Phytophthora palmivora*.

Capsids had very severely damaged the trees before 1951 but part of the farm was treated in 1951-2 and the whole in 1952-3 with 5 per cent D.D.T. dust, and there was little capsid damage at the beginning of this trial.

There were four treatments, 0.03 per cent D.D.T. emulsion, carbide-Bordeaux containing 0.03 per cent D.D.T. emulsion and Control.

Spray was applied to the pods only at intervals of three weeks from 1st July to 3rd November and on 24th January, 1954.

At the beginning of the experiment in early June 1953 the capsid populations in the four plots were approximately equal, between 39 and 58 bugs per 100 trees.

The populations in the plots varied somewhat throughout the year, but for most of the period the number of bugs in the untreated plots was greater than that in any of the treated plots, particularly between October and December.

The number of capsids in the four plots again became similar after spraying was stopped. Spraying reduced capsid populations but not sufficiently to prevent the trees from deteriorating rapidly.

STUDIES OF THE BIOLOGY AND CONTROL OF SHOT HOLE BORERS IN YOUNG CACAO PLANTS—J. E. GREGORY

During the year authoritative identifications of the various shot hole borers attacking cacao have been received from Professor Dr K. E. Schedl of Austria. Dr Schedl has also provided a key to these species and the taxonomic side of the study of cocoa shot hole borers has now been clarified.

There are several changes in the names of the species concerned and the old and new names of the various beetles are put down together below in Table 40.

TABLE 40.—SYNONYMY OF SCOLYTIDS ON COCOA IN NIGERIA

Name previously recorded					Corrected determination
<i>Xyleborus compactus</i> Eichoff	..	..	..	..	<i>X. morstatti</i> Hag.
<i>Hypothenemus ater</i> Egg.	..	..	..	..	<i>Stylotentus ater</i> Egg.
<i>Stephanoderes theobromae</i> Egg.	..	..	..	..	<i>Stephanoderes solitarius</i> Schedl.
<i>S. polyphagus</i> Egg.	..	..	..	..	<i>S. polyphagus</i> Egg.
<i>H. pusillus</i> Egg.	..	..	..	..	<i>H. pusillus</i> Egg.
Not previously named	..	..	..	..	{ <i>Stephanoderes aulmanni</i> Hag. <i>Poecilips confusus</i> Egg.
<i>Hypothenemus subvestitus</i> Egg.	..	..	..	..	{ <i>S. punctatus</i> Egg. <i>S. perhispidus</i> Egg. <i>S. pubipennis</i> Egg. <i>Hypothenemus tuberculosus</i> Hag.

It will be seen that six more species have been added to the list of Scolytids attacking cocoa and one, wrongly identified, has been removed. The most important beetle, previously called *Xyleborus compactus* Eichoff, is actually *X. morstatti* Hag., a widely distributed pest of young cocoa in West Africa. Other changes are the substitution of *Stephanoderes solitarius* Schedl for *S. theobromae* Eggers and a change of the genus of *Hypothenemus ater* Eggers to *Stylotentus*. The additions to the list are all very small beetles formerly called *Stephanoderes subvestitus* Eggers and frequently confused with *H. pusillus* Eggers. They are of no economic importance.

Poecilips confusus Eggers has also been recorded attacking and causing dying back of young seedlings. It appears similar in habits and life history to *X. morstatti*. It is, however, very rare and is only of minor importance.

In the year 1953-4, little damage was done to seedling cacao by shot hole borers. The rainfall in the dry season was good and few attacks by shot hole borers were recorded. Consequently, material for study was rather difficult to obtain and this limited the amount of work which could be done.

Life History of Xyleborus morstatti.—The most important of the shot hole borers attacking cacao seedlings is *X. morstatti*.

The gallery is made by a single female, entry typically taking place on the smooth surface of the bark, not at a leaf base. The gallery extends radially into the centre of the seedling where a rounded brood chamber is excavated.

A batch of about twenty eggs is laid in the first two or three days, after which the rate of egg laying falls off rapidly. The number of young produced by a single female varies considerably. In the case of 14 chambers of *X. morstatti* containing pupae or young adults, the number of progeny ranged between five and 54 with a mean number of 29.4.

The larvae are a milky white colour and their gut contents are never darker than the rest of the body; in this respect the larva differs from other Scolytids which feed on the wood and pith of the cacao seedlings.

The average ratio of males to females for 163 beetles is 1 : 4.6 but in individual galleries, this ratio has ranged between 1 : 1.5 and 1 : 9.

The length of the life cycle is not known because attempts to rear the insect through from adult to adult have not yet succeeded, largely owing to the difficulty of feeding the larvae. The durations of the egg and pupal stages are approximately five, and six to seven days respectively.

In the early stages of development of the brood chamber a white fungus layer about 1 mm. thick is visible on the walls of the chamber. It is probable that this layer contains an ambrosia fungus, but cultures of the fungus have not given consistent results.

Pieces of mycelium from three galleries have given rise to the fungus *Botryodiplodia theobromae*, twice from *X. morstatti* and once from *S. solitarius* galleries. This fungus commonly occurs as a weak parasite of cacao in Nigeria. It is possible that it is present as a contaminant of the ambrosia fungus which may not grow in the culture medium used.

It is interesting to note that Gowdey (1918)* reported that "*Xyleborus camerunus* Hag. attacks cacao, but caused death only in those plants already infested with the fungus, *Diplodia*."

Damage Caused to Cacao Seedlings.—The wood immediately surrounding the brood chamber and for a distance of about half an inch above and below it is stained a dark brown colour. Death of the plant often occurs $\frac{1}{2}$ " to $\frac{3}{4}$ " below the entrance hole of the beetle, the dividing line between the live and dead portions of the wood being very sharp.

The presence of *X. morstatti* in a seedling is often indicated by a swelling or a shrinking of the stem around the brood chamber. The shrinking of the wood begins just below the point of entry and is due to the shrinking of the bark subsequent to its death. The cause of the swelling which occurs occasionally in the wood, is not known.

Additional damage to seedling cacao is often caused by the entry of secondary fungi into borings caused by the Scolytids and such infection is one of the major causes of seedling death.

Control Experiments.—Attempts to prevent death of seedlings by the use of insecticides applied by brush to cacao seedlings have given little information of value. This lack of success is partly due to environmental conditions having a greater effect upon seedling death than has Scolytid attack, and partly to the small numbers of seedlings available for trial under field conditions.

Experiments have been designed to test the effect of insecticide applied to twigs of mature cacao trees. One twig 12 inches long was stripped of its leaves and broken from each of a number of cacao trees. The twigs were then tied onto the tree, painted with different insecticidal solutions at various concentrations and left for ten days. At the end of this period, the twigs were dissected and the number and condition of Scolytid galleries was recorded. Results for the best concentration of each insecticide solution are given in Table 41.

* Gowdey C. C., 1918, Uganda Dep. Agric. Ann. Rept. for year ending 31st March, 1918, pp. 42-51, Kampala.

TABLE 41.—EFFECT OF INSECTICIDES ON ENTRY OF SCOLYTIDS
INTO BROKEN CACAO TWIGS

<i>Insecticide</i>	<i>Actual Concen- tration per cent</i>	<i>Percent- age Twigs undamaged</i>	<i>Colonies per 100 twigs</i>	<i>Dead Scolytid and Empty Galleries</i>	<i>Live and Breed- ing Colonies</i>
D.D.T. emulsion concentrate (A)	2.5	70	37	8	3
Aldrin emulsion concentrate ..	1	65	48	10	19
Dieldrin emulsion concentrate ..	1	83	17	9	1
Endrin emulsion concentrate ..	1	88	12	3	4
D.D.T. emulsion concentrate (B)	2.5	83	17	4	1
Control	—	12	158	21	74

Endrin was the most effective in preventing Scolytid entry and Dieldrin in preventing breeding. Endrin is preferable because it is desirable to prevent entry in order to minimise the harmful effect of secondary fungi.

STUDIES ON THE BIOLOGY AND CONTROL OF BEETLES ATTACKING YAMS— J. L. GREGORY

In late 1953, serious attack by yam beetle (*Heteroligus meles* Billb.) was reported on the Western Region Department of Agriculture Farm at Effurun in Warri Province. The yam barn at Effurun was inspected in January to determine the rate of attack and the loss in weight of yams.

A representative sample was taken from all parts of the barn, and these yams were counted and the number showing beetle attack noted. Yams from part of this sample were then washed and weighed. The holes caused by yam beetle were filled up with plasticene and the yams were weighed again. The difference between the two weights, the weight of plasticene, was corrected for the different specific gravities of yam and plasticene, and the amount of yam eaten by beetles was thus obtained. 1,344 yams were inspected to determine the percentage attack rate and from these, the yam beetle holes in 190 of the attacked yams were measured.

The figures for percentage attack rate of the samples varied from 41 per cent to 91 per cent with an overall average of 67 per cent. The figures for percentage loss for individual yams varied from 0.9 to 44.9 per cent with an average of 11.2 per cent of the total weight of yams remaining.

The weight of 190 damaged yams was 153 lb 10 oz and the weight of yam which would fill the holes was 17 lb 4 oz. The attack rate is 67 per cent. Therefore, the percentage loss in

weight would be $\frac{17.25 \times 67}{153.875 \times 100}$ or 7.5 per cent loss in weight.

This loss in weight is comparatively small but is in general accordance with figures obtained from an experiment at Ogoni in Rivers Province in 1950 where an infestation of 91 per cent of yams attacked gave a loss of 8.3 per cent of total yam weight.

INSECTICIDAL CONTROL OF MAIZE STEM BORERS AT IBADAN—J. R. G. SUTHERLAND
AND J. L. GREGORY

Three experiments were carried out at Ibadan to test the effect of applying insecticides upon the infestation of stem borers and upon the yield of maize. The variety used was Lagos White.

Early Maize.—A randomised block layout with 12 replications of six treatments was used in the experiment upon the early crop. Each plot was split into three sub-plots which were sown at intervals of one month.

Five insecticides were applied to young maize plants about thirty inches high, until run off occurred from all leaf axils.

After harvest, plants were split in each plot up to a maximum of sixty plants per plot. The number of attacked and unattacked joints in each plant was recorded. Any borer larvae or pupae noted were identified. The results are given in Tables 42 and 43.

TABLE 42.—THE EFFECT OF INSECTICIDES UPON YIELD AND BORER INFESTATION OF
EARLY MAIZE : IBADAN 1953

<i>Insecticide</i>	<i>Formulation</i>	<i>Concentration of insecticide per cent</i>	<i>Yield in lb dry grain per acre</i>	<i>Percentage plant infestation</i>	<i>Percentage joint infestation</i>	<i>Post harvest borer count (borers per 100 plants)</i>
Aldrin ..	Emulsion	0.032	360.6	24.5	4.01	3.88
	Concentrate					
Dieldrin ..	Emulsion	0.068	367.0	21.7	3.49	5.07
	Concentrate					
Endrin ..	Emulsion	0.034	388.9	21.3	3.74	4.51
	Concentrate					
B.H.C. ..	Miscible	0.0094	323.8	24.6	4.01	5.05
	Liquid					
D.D.T. ..	Miscible	0.06	339.2	23.6	3.85	3.62
	Liquid ..					
Control ..		—	344.4	23.7	3.91	4.18
Average ..		—	354.0	23.2	3.84	4.38
Standard Error of a Difference between two means of 36 plots			20.67	Not significant		
Significant difference at 5 per cent			41.4			

TABLE 43.—THE EFFECT OF SOWING DATE UPON YIELD AND STEM BORER INFESTATION OF
EARLY MAIZE : IBADAN 1953

<i>Planting Date</i>	<i>Yield in lb dry grain per acre</i>	<i>Percentage plant infestation</i>	<i>Percentage joint infestation</i>	<i>Post harvest borer count (borers per 100 plants)</i>
10th March	817.0	20.0	2.4	2.7
10th April	263.6	25.0	4.2	7.3
10th May	89.8	24.7	4.3	3.0
Average	354.0	23.2	3.8	4.4
Standard error of a difference between 2 means of 72 plots				
	14.0	1.8	0.4	0.9
Significant difference at 5 per cent	27.7	3.5	0.7	1.7
Significant difference at 1 per cent	36.6	4.7	0.9	2.2

The average yield was higher in plots treated by Endrin, Dieldrin and Aldrin than in the control plots by 44.5, 22.6 and 16.4 lb of dry grain per acre respectively. Endrin treated plots alone gave a significant increase ($P = 0.05$).

Insecticides caused no significant decrease in the numbers of stem borers, although plots treated with Endrin and Dieldrin had slightly lower populations than the other plots.

The effect of planting date upon yield and infestation is considerable and is shown in Table 43. The yield of the earliest sown maize was considerably greater and the infestation rates lower than that of later planted maize. Such a large decrease in yield could not be attributable to borer attack.

The differences due to different planting dates are great and might have obscured treatment effects. Accordingly, the results for the first planting alone were analysed but no significant differences between treatments were found. Furthermore the increase in yield following applications of Endrin was not large enough to be significant at the first sowing date.

The plant and joint infestation rates were 23.2 per cent and 3.8 per cent respectively over the whole experimental area, and 23.7 per cent and 3.9 per cent respectively in the control plots. *Busseola fusca* Full. was the most common species present both in the stalk and in the cobs. *Sesamia calamistis* Hamps. and *Argyroproce leucotreta* Meyr. were also important particularly in the cobs and silks.

Late Maize Crop.—The experiment was repeated upon the late maize crops using the same insecticides, concentrations, and experimental layout. The results are shown in Tables 44 and 45.

TABLE 44.—THE EFFECT OF INSECTICIDES UPON YIELD AND STEM BORER INFESTATION OF LATE MAIZE : IBADAN 1953

Treatments						Yield in lb dry grain per acre	Percentage plants attacked	Percentage joint infestation	Post harvest borer count (borers per 100 plants)
Aldrin	..	..	..	..	..	401	23.54	4.18	3.95
Dieldrin	..	..	..	..	..	401	22.78	4.26	3.06
Endrin	..	..	..	..	..	385	19.40	3.37	3.99
B.H.C.	..	..	..	..	..	330	24.02	4.87	4.18
D.D.T.	..	..	..	..	..	349	23.48	4.47	2.79
Control	..	..	..	..	..	321	26.24	5.02	3.53
Average	..	..	..	..	..	364	23.24	4.36	3.58
S.E. of diff. between 2 means of 36 plots ..						22.6 lb	2.00	0.50	} No signifi- cant difference
Significant difference at 5 per cent ..						45.3 ..	4.01	1.00	
Significant difference at 1 per cent ..						60.3 ..	5.34	1.33	

TABLE 45.—THE EFFECT OF PLANTING DATE UPON YIELD AND STEM BORER INFESTATION UPON LATE MAIZE : IBADAN 1953

Sowing Date					Yield lb dry grain per acre	Percentage plants attacked	Percentage joint infestation	Post harvest borer count (borers per 100 plants)
15th August	..	..	..	..	265	32.00	3.23	4.77
30th August	..	..	..	..	455	16.73	3.21	3.23
14th September	..	..	..	..	373	20.99	5.64	2.75
Average	..	..	..	..	364	23.24	4.36	3.58
Standard Error of difference between 2								
means of 72 plots	..	..	..	..	15.2	1.62	0.34	No significant difference
Significant difference :								
at 5%	..	..	..	..	30.1	3.20	0.67	
at 1%	..	..	..	..	39.8	4.23	0.89	

The yield of all the treated plots was greater than that of the control plot. The application of Aldrin and Dieldrin gave a significant increase ($P=0.01$) of 80 lb dry grain per acre or 24.9 per cent above the control. The yield of Endrin treated plots was also higher than those of untreated ones (significant at the 1 per cent level).

All the insecticides reduced stem borer attack. Endrin was the most effective, reducing joint infestation from 5.02 per cent to 3.37 per cent and plant infestation from 23.2 per cent to 19.4 per cent. These differences, while significant, are not large and it is rather surprising that a reduction of 16.4% [$(23.2 - 19.4) \times 100 \div 23.2\%$] in plants attacked or 32.9 per cent in joint infestation should result in an increase of 24.9 per cent in yield. The difference might be due to a lower plant population in the control plots due to early attacks by stem borers.

Time of sowing again affected both the yield and the infestation rate. The yield at the second planting date was the highest and the stem borer attack lowest. The reverse occurred at the first planting date.

The plant and joint infestation was 23.2 per cent and 4.4 per cent respectively over the whole experiment and 26.2 per cent and 5.0 per cent respectively in the control plots. About three quarters of the borers attacking stalks were *S. calamistis*, with *B. fusca* forming the majority of the remainder. *A. leucotreta* formed more than half of total cob borers. The number of borers remaining at harvest and the joint infestation figures are poorly correlated. Consequently, the relative proportions of the species remaining in the plants after harvest may not be an accurate estimate of the species which caused damage.

A further trial was carried out upon the late maize crop to test the effect of Aldrin, Chlordane and Heptachlor upon yield and infestation by stem borers. There were two planting dates at an interval of two weeks and the layout was a series of 2×2 Latin Squares, each plot being split into four treatments. The results of the treatments are given in Table 46.

TABLE 46.—THE EFFECT OF INSECTICIDES UPON YIELD AND BORER INFESTATION OF LATE MAIZE : IBADAN 1953

<i>Treatments</i>	<i>Formulation</i>	<i>Concentration of insecticide per cent</i>	<i>Yield lb dry grain per acre</i>	<i>Percentage plant infestation</i>	<i>Percentage joint infestation</i>	<i>Post harvest borer count (borers per) 100 plants</i>
Heptachlor	Wettable Powder	0.08	580	40.6	8.6	33.3
Chlordane	Wettable Powder	0.05	558	40.4	9.0	38.3
Aldrin	Emulsion	0.03	512	42.0	9.8	32.5
Control	Concentrate		561	46.7	10.7	42.5
Average	—	—	552.6	42.4	9.6	36.7
Standard Error of a difference between 2 means of 24 plots			Not significant	2.4	0.7	Not significant
Significant difference :						
at 5%				4.8	1.4	
at 1%					1.8	

The effect of insecticides upon yield was not significant. Infestations were reduced slightly by all the insecticides. These reductions were statistically significant, but were not high. Heptachlor caused a reduction of 19.9 per cent in joint and 14.3 per cent in stem infestation.

The overall plant and joint infestations were 42.4 per cent and 9.6 per cent respectively and those of the control plot were 46.7 per cent and 10.7 per cent respectively. *Sesamia calamistis* and *Busseola fusca* were present in the stems in approximately equal numbers.

Discussion.—The plant infestation rates upon the early and late maize crops were identical and the two joint infestation rates were similar. Nevertheless, three insecticides produced an increase in yield significant at 1 per cent upon the late crop but only one insecticide gave a barely significant increase upon the early crop.

Thus an infestation rate that causes important damage to the late crop may cause much less damage to the early crop. This is probably because the higher rainfall and nutrient status of the soil in the early crop season allows plants to withstand borer attack which would cause severe damage in the late crop.

Endrin has given yield increases in all experiments and appears to be the most promising of the insecticides tried so far, but the increases in yield recorded are not big enough to bear the cost of the insecticide.

The insecticidal control of maize stem borers has been attempted since 1952. In neither year has any insecticide given a significant increase in yield when applied to early maize and it is doubtful if consistent increases in yield could be obtained by treating the early maize crop.

A SURVEY OF THE DISTRIBUTION IN NIGERIA OF THE SORGHUM MIDGE—

J. R. G. SUTHERLAND AND J. L. GREGORY

Following the discovery of sorghum midge, *Contarinia sorghicola* Coq., in Nigeria in March 1953, Agricultural Officers in all three regions of Nigeria were asked to forward seed heads of as many species of cereals and grasses as possible to Ibadan so that the distribution of sorghum midge throughout Nigeria might be clarified. Seed heads were received from 37 different localities throughout Nigeria and cecidomyid midges were reared from 18 of these. These midges were sent to Dr H. F. Barnes in England for determination.

Identifications of all the material have not yet been received from England and so a complete report on the survey cannot be given. However, it is possible to give some information from the survey. Table 47 shows records of presence or absence of midges in the various species of Gramineae in the different localities. There are numerous localities and some grass species from which no midge has yet been reared, but a negative result in a survey conducted in this fashion signifies very little.

Sorghum midge has been recorded from *Andropogon gayanus* Kunth., (gamba grass) and from *S. arundinaceum* R. S., *S. vulgare* Pers. and *S. vulgare* Pers. vars. *durra*, *saccharatum*, *caudatum* and *guineense*. Other species of midges have been found on *Panicum maximum* Hochst. and *Pennisetum pedicellatum* Trin.

The distribution of sorghum midge in Nigeria is not completely known, but it has definitely been identified from two localities notably Ibadan in the Western Region of Nigeria and Samaru near Zaria in the Northern Region. Relatively few seed heads were received from the Eastern Region of Nigeria and there is only one rather doubtful record of any midge being reared from this material.

The Eulophid parasite, *Tetrastichus* sp. which was reported by Geering* to be attacking *C. sorghicola* in Uganda has also been found in Nigeria in association with cecidomyid midge on cereals.

TABLE 47.—DISTRIBUTION OF CEREAL MIDGES IN NIGERIA, 1953

Station	Sorghum Species										<i>Pennisetum pedicellatum</i>	<i>Panicum maximum</i>	<i>Andropogon gayanus</i>
	<i>guineese</i>	<i>vulgare</i>	<i>saccha- ratu</i>	<i>cauda- tum</i>	<i>durra</i>	<i>exsertum</i>	<i>roxburghi</i>	<i>arundin- aceum</i>	<i>other species</i>				
Samaru	MP	MP	M	MP	MP	M	M	—	MP	—	MP	—	
Maiduguri	—	—	—	Nil	P	Nil	—	—	—	M	—	Nil	
Gusau	M	—	—	—	—	—	—	—	—	Nil	Nil	—	
Gombe	Nil	—	P	—	—	—	—	—	—	Nil	—	Nil	
Yandev	—	—	—	—	—	—	—	—	—	M	—	M	
Ikeja	—	—	—	—	—	—	—	M	—	—	—	—	
Epe	M	—	—	—	—	—	—	—	—	—	—	—	
Ijoko	M	—	—	—	—	—	—	—	—	—	—	—	
Ilugun	—	—	—	—	—	—	—	M	—	—	M	—	
Ibadan	M	—	—	—	—	—	—	—	—	—	M	—	
Ilesha	—	—	—	—	—	—	—	M	—	—	—	—	
Ede	—	—	—	—	—	—	—	M	—	—	—	—	
Ejigbo	M	—	—	—	—	—	—	—	—	—	—	—	
Akinmorin	—	—	—	—	—	—	—	MP	—	—	—	—	
Ogbomosho	Nil	—	—	—	—	—	—	MP	—	—	MP	—	
Iseyin	—	—	—	—	—	—	—	MP	—	—	—	—	
Itele	—	—	—	—	—	—	—	—	—	—	M	—	
Ado-Ekiti	M	—	—	—	—	—	—	—	—	—	—	—	
Ogoni	—	—	—	—	—	—	—	—	—	—	M(?)	—	

KEY

- M = Midges recorded.
- P = Parasites recorded.
- Nil = No insects emerged from seed heads.

* Geering, Q. A., 1953, Bull. Ent. Res., 44, p. 363.

INVESTIGATION ON COTTON PESTS IN NORTHERN NIGERIA—M. A. CHOYCE

Observations on the incidence of the major pests of cotton have continued at Samaru, Daudawa, Kontagora, Gusau, Gombe and Yola throughout the season.

Insecticide trials were held at Samaru, Daudawa and Kontagora, but no marked increases in yield were obtained in any of these experiments. Nevertheless, at Samaru information was obtained concerning the effects of control of mirids.

Observations on the emergence of adults of Red Bollworm from long-term pupae during 1952-53 have been completed.

Diparopsis perditor—Red Bollworm.—The heaviest attack of Red Bollworm occurred at Kontagora and Gombe; elsewhere the incidence was less and did not differ greatly from that recorded last year. Eggs were found throughout the season in most areas, and the maximum numbers of larvae were found during October and November.

Platyedra gossypiella—Pink Bollworm.—Pink Bollworm were found in all areas, usually from late October onwards. At Samaru and Daudawa incidence was again low, and the largest populations were found at Yola and in Numan Division.

Other Bollworms. *Earias* spp.—(Spiny and Egyptian Bollworms) were reported from all areas, with between 2,000 and 3,000 per acre occurring in green bolls during late October and November. The attack was heaviest at Gombe, where nearly 10,000 per acre was recorded in December. Additional damage to growing points was caused by these bollworms early in the season.

Argyroplote leucotrota (False Codling Moth) and *Heliothis armigera* (American Bollworm) were uncommon in all areas.

Dysdercus supersticiosus—Cotton Stainer.—Stainers moved into the crop during September and generally remained in the crop until harvest. At Gombe and Kontagora over 10,000 per acre were recorded during October. Elsewhere peak populations of 2,000-3,000 per acre occurred except in Numan Division, where numbers were generally higher.

At Samaru few stainers were found after an early migration into the crop, and it is possible that breeding occurred before suitable food (split bolls) was available for the nymphs.

Mirids and Leaf Tattering.—Mirids were again common at Samaru. On the Insecticide Trial the population of *Campylomma* was much less than last year. Migration into the crop reached a peak of only 1,600 swept per acre during early October. *Lygus*, though present in far fewer numbers than *Campylomma*, was more common than last year.

Tattering was again extremely variable. On the Main Farm at Samaru it was moderate, while parts of the Extension fields suffered considerably. At Daudawa tattering was common, particularly at Shemi where in spite of excellent growth, some patches failed to set bolls early in the season. In other areas tattering was generally slight.

Provisional indications at Samaru are that a moderate mirid attack does not reduce the final yield of the crop but merely delays its maturation. Yield figures show that the cotton plant is able to compensate for early damage by further growth and fruiting. Adequate control can be achieved by weekly applications of 1 lb of D.D.T. per acre during the build-up of the mirid population in September and early October.

Full details of the results of the season's work have been published in the Empire Corporation's "Progress Report from Experiment Stations, Season 1953-54".

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